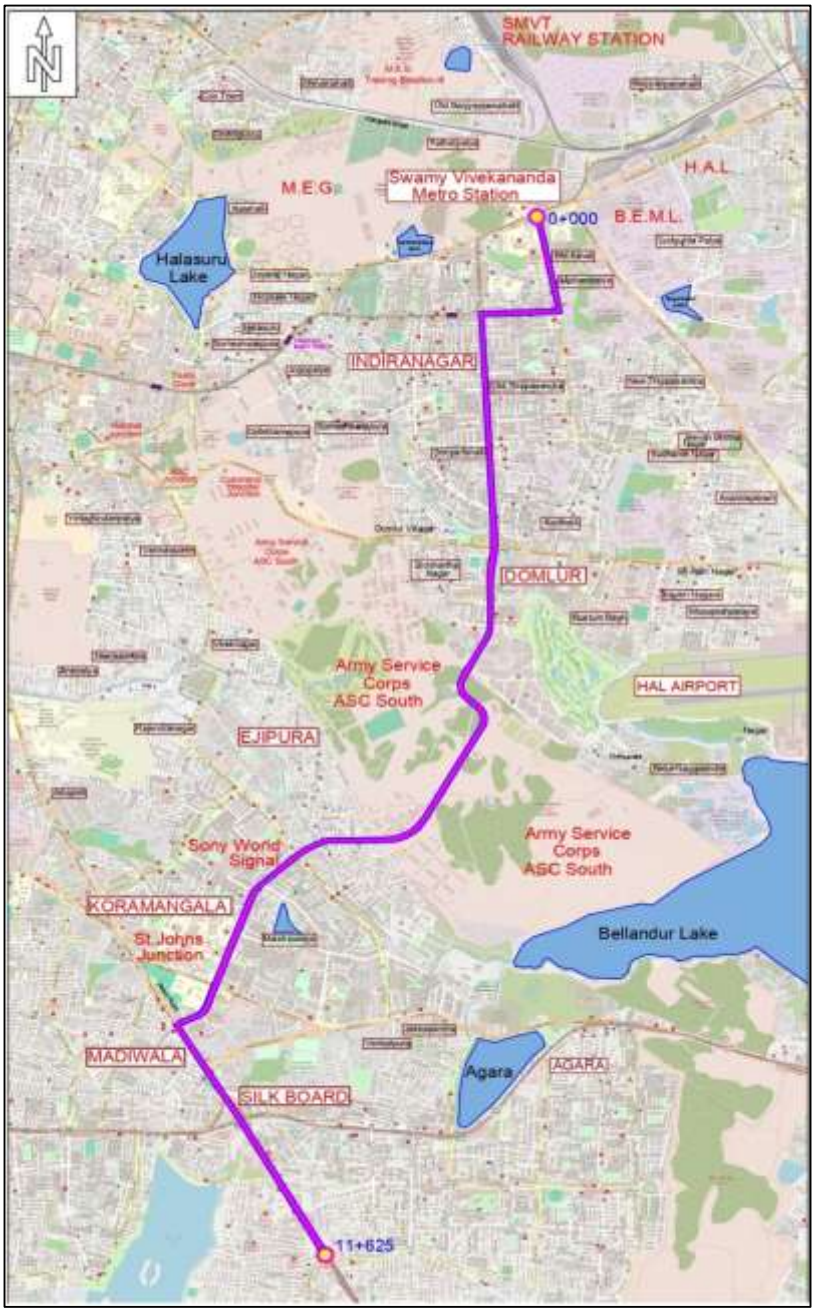
BENGALURU SMART INFRASTRUCTURE LIMITED (B – SMILE)
Office of the Chief Engineer-02
#30/1,Thimmaiah Road, Miller Tank Bund Area,
Vasanth Nagar, Bengaluru - 560051.

Construction of Proposed Elevated Corridor from Old Madras Road from Swami Vivekananda Metro Station to Silk Board Junction on Hosur Road via Indiranagar – Domlur - Madiwala



Swami Vivekananda Metro Station

Domlur Interchange

Silk Board Junction

Consultant: **Siddi Shakthi Projects**
No.93/31, Asha Nivas, T.G. Layout,
Ittamadu, Banashankari 3rd Stage,
Hosakerehalli Post, Bengaluru-560085
Telephone No : 080 – 43008989, E-mail : ssprj2001@gmail.com,

Detailed Project Report
Project Cost = 1300.00 Crores
February – 2026
Volume-I

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Phone No : + 91 80 43008989, Email : ssprj2001@ gmail.com, siddishakthiprojects @ gmail.com.

REF: SSP/OC/25-26/0104 **Date: 20-02-2026**

CERTIFICATE

Name of the Project	:	Construction of Proposed Elevated Corridor from Old Madras Road from Swami Vivekananda Metro Station to Silk Board Junction on Hosur Road via Indiranagar-Domlur-Madiwala
Total Project Cost	:	**Rs. 1300.00 Crores (Proposed to implement under EPC Model)**
Grant	:	1. Brand Bengaluru 2. Budget 2025-26, Dated: 7th March 2025, Urban Development, Sl. No. 283 (ii), Page No. 79 3. Subject No 448/2024-25.
Tendering Authority	:	Bengaluru smart infrastructure limited (B – SMILE) No.30/1, Thimmaiah Road, Millar Tank bund Area, Vasanthnagar, Bengaluru-560051.
Project Consultant	:	**Siddi Shakthi Projects,** No.93/31, Asha Nivas, TG Layout, Ittamadu, Banashankari 3rd Stage, Hosakerehalli Post, Bengaluru – 560085.
Name of the Assignment	:	Preparation of Detailed Project Report (DPR)
Period of Preparation of Detailed Project Report	:	21-04-2025 to 22-01-2026
Report submitted to	:	Bengaluru smart infrastructure limited (B – SMILE) No.30/1, Thimmaiah Road, Millar Tank bund Area, Vasanthnagar, Bengaluru-560051.
Report prepared by	:	**Mr. H.V. Mallikarjuna,** Team Leader
Reviewed by	:	**Dr. Mandar V.Sardesai,** Advisor (Structures)
Approved by	:	**Mr. M. Kannan,** Chief Executive Officer
Total No. of Pages	:	**Detailed Project Report** **Volume- I : 1 to 359** **Volume-II : 360 to 431**

Thanking and assuring you of our best services at all times,

For Siddi Shakthi Projects,

Authorized Signatory

Notes:

- This report is Prepared only for the purpose of tendering for the specified project. If any substantial change in the report is noticed, the same should be brought to the notice of **Siddi Shakthi Projects,** if found necessary, recommendations and appropriate modifications shall be Suggested.
- This report should not be reproduced, without written approval of **Siddi Shakthi Projects.**
- Any correction made shall invalidates this report.

Executive Summary & Techno -Economic Details (Brief Overview of DPR)

Sl No	Description	Details
1	Name of Project	Construction of Proposed Elevated Corridor from **Swami Vivekananda Metro Station to Silk Board**
2	Length of the project	11.625km
3	Total length of elevated structures with a span of 45m including four lane straight reaches, split flyover in the form of loops and approaches.	13.049Km Four lane carriage way 17.20m = 0.677 km Two lane carriage way 12.00m = 2.925 km $1^1/_2$ lane carriage way 8.50m = 9.447 km
4	Structural area of deck slab Including Approach viaduct and area of Solid approach ramp (RE Wall)	111573 Sqm (Deck slab) + 5280Sqm(Solid approach) The project incorporates advanced structural technology using **UHPFRC girders** to achieve longer spans, reduced structural depth, and optimized lifecycle performance.
5	Allied works including improvement and reconstruction of road, footpath, drain, utility ducts etc.	5.20 Km
6	Total Civil cost for execution of the project	Rs 852.00 Cr (Elevated corridor + allied works)
7	Total Provisional Cost including GST and other miscellaneous like price escalation, utility shifting, PMC charges,	Rs 448.00Cr (inclusive of Land acquisition cost of Rs 171.38Cr)
8	Total Project Cost Including civil and provisional cost	Rs 1300 Cr
9	Structural Cost / Sqm	Rs 70474 / Sqm
10	Structural cost per Sqm in terms of overall finishing work of flyover and at grade road work including all allied works	Rs 72,913/ Sqm
11	Normative cost of MORT&H for Flyover / Sqm	Rs 40,000/Sqm (does not include finishing work, at grade road work etc.,) location considered to be in non-urban area
12	Cost / Sqm of Structural area compared to Ongoing work at Nagpur flyover with UHPFRC Girder	Rs 56,280/Sqm (without improvement works)
13	Structural cost / Sqm , for this Project if executed with typical type of flyover with segmental Box Girder with a span of 30m	Rs 1,11,958/Sqm as against UHPFRC Girder cost of Rs 70,474/Sqm
14	Economical Internal Rate of Return	With an EIRR of 16.80% (>12%) and a BCR of 1.99 (>1), the project is economically viable and recommended for implementation.”
15	Concept plan, Technical feature were reviewed by Stalk holder of Govt. Agencies.	NHAI, DULT,BMRCL,BWSSB , Commissioner of Traffic Police, Technical Advisory Committee of BSMILE
16	Mode of Tender	Engineering, Procurement and Construction (EPC)

1. Introduction

General

Bengaluru, one of India's major metropolitan cities, has witnessed rapid urbanization driven by population growth, economic expansion, and spatial development. This has resulted in a steep rise in urban travel demand. Unfortunately, the surge in travel demand has led to several undesirable consequences, the most significant being the exponential growth in motor vehicle ownership. Simultaneously, the share of public transport has declined, with commuters increasingly relying on personal vehicles. This trend has imposed serious costs in the form of traffic congestion, travel delays, productivity losses, deteriorating air quality, and rising road accidents.

Projections indicate that by 2031, Bengaluru's population will far exceed current expectations, translating into nearly double the present volume of daily vehicle trips. This escalation poses a critical challenge to the city's quality of life. Importantly, travel demand is closely linked to economic growth, which in Bengaluru is progressing at an even faster pace than population growth. Proactive measures are therefore essential to address the emerging situation.

Over the past decade, Bengaluru has seen considerable investment in transport infrastructure, including IT parks, ring roads, flyovers, bridges, and underpasses. While these projects were intended to ease congestion, the city continues to face severe traffic bottlenecks. Vehicle registrations are increasing by 400,000–600,000 annually, while the total road length remains largely unchanged. Several junctions have already exceeded their design capacity, necessitating immediate interventions to improve traffic flow.

Urban transport in Bengaluru is predominantly road-based. National rail lines were not designed to serve urban and regional traffic, with infrequent stations and low service frequency. Road traffic is dominated by motorized two-wheelers and auto-rickshaws. Public transport, primarily operated by the Bangalore Metropolitan Transport Corporation (BMTC), functions in mixed traffic without dedicated lanes or signal priority. Many companies also operate private minibus fleets for employee transport. The BMTC network, though extensive, is diffuse and characterized by low service frequency. Metro connectivity through BMRCL is expanding, but remains insufficient to meet the city's growing demand.

Despite the construction of multiple flyovers and grade separators by the Bangalore Development Authority (BDA) and Bruhat Bengaluru Mahanagara Palike (BBMP), congestion persists. The city's road network, largely laid out in the 1940s when the population was under half a million, is underdeveloped in terms of size, continuity, and connectivity. Today, links and intersections operate at or above capacity. Average journey speeds on key central roads during peak hours range between 5–13.5 kmph, making daily commuting highly inefficient. Nearly all major junctions are over capacity, and traffic growth has far outpaced infrastructure expansion.

Bengaluru, the fifth largest city in India, has an estimated population of 14 million spread over 821 sq. km. Vehicle growth rates exceed 15% annually, compared to a population growth rate of 5%. The city's radial road network comprises six National Highways and five State Highways, supplemented by circumferential roads such as the Inner Ring Road, Intermediate Ring Road, Outer Ring Road, West of Chord Road, NICE Corridor, Airport Road, and the Peripheral Ring Road (under construction).

Recognizing the gravity of the situation, the Government of Karnataka, under the Greater Bengaluru Authority (GBA), has established Bengaluru Smart Infrastructure Limited (B-SMILE), a Special Purpose Vehicle (SPV) to implement mega infrastructure projects. These include:

- Underground Vehicular Tunnels: North–South Corridor (Hebbala to Silk Board, 18 km) and East–West Corridor (K.R. Puram to Nayandahalli, 24 km).
- Elevated Flyover Corridors & Double-Decker Flyovers: 120 km.
- White topping (PQC) of Major Roads: 350 km.
- Road Widening Projects: Over 50 km within the city.
- Buffer Zone Road Construction: More than 300 km along lakes and storm water drains.

These initiatives, including the proposed Elevated Corridor Project, are critical to addressing Bengaluru's escalating traffic congestion, improving mobility, and sustaining economic growth.

1.1 Background

Bengaluru, historically founded by Kempe Gowda, a feudatory of the Vijayanagara Empire, was once renowned for its lush greenery and abundant water bodies. In the 1970s, the city enjoyed a green cover of nearly 68%, with splendid lakes, numerous parks, and tree-lined avenues defining its landscape. Until that period, Bengaluru's economy was primarily driven by the manufacturing sector. Post-Independence, preferential policies of the Government of India further strengthened the city's economic base, with several Public Sector Undertakings (PSUs) establishing their headquarters here. The presence of reputed universities and colleges added to its stature as an educational hub.

The State Government's initiatives in the Information Technology sector, such as the establishment of the Karnataka State Electronics Development Corporation (Keonics) and the creation of Electronics City, provided a major boost to industrial growth. The availability of quality education, coupled with the emergence of new industries, created vast opportunities for the youth, leading to large-scale migration into the city. This sudden influx posed challenges for the Bengaluru Mahanagara Palike, which struggled to meet the growing demands. Numerous unplanned revenue layouts emerged across the city, many of which fell outside the jurisdiction of the Municipal Corporation and were consequently neglected in terms of infrastructure and services.

Bengaluru's success in attracting large-scale private investment from across the globe further accelerated its growth trajectory. Between 1993 and 2004, while India's GDP grew at an average rate of 7.93%, Bengaluru recorded an impressive 20.76% growth rate. The city's IT sector, contributing nearly 40% of India's software exports, played a pivotal role in bridging the nation's trade deficit and cementing Bengaluru's reputation as the "Silicon Valley of India."

However, this remarkable growth story has been accompanied by significant infrastructure-related challenges. Traffic congestion, deteriorating air quality, poor waste management, water scarcity, and inadequate road maintenance have adversely impacted the quality of life in the city. These issues have also affected the image of "Brand Bengaluru," underscoring the urgent need for sustainable infrastructure solutions. The proposed Elevated Corridor Project from Sirsi Circle to Nayandahalli is one such initiative aimed at addressing these challenges by improving mobility, reducing congestion, and supporting the city's continued economic growth.

1.2 Development of Bengaluru

Bengaluru, with a current population of approximately 14 million, has been growing at an annual rate of 3.25% over the last decade. This rapid urban expansion has been accompanied by a phenomenal increase in vehicle ownership, particularly two-wheelers and four-wheelers, driven by rising household incomes. The number of registered motor vehicles has already crossed 12 million, placing immense pressure on the city's limited road network.

In the absence of an adequately developed public transport system, citizens have increasingly relied on personalized modes of travel. This has resulted in severe traffic congestion, escalating environmental pollution, and declining urban mobility. Studies indicate that an average citizen of Bengaluru spends more than 240 hours annually stuck in traffic. Such delays translate into significant productivity losses, deterioration of air quality, reduced quality of life, and increased costs for goods and services.

Traffic composition on Bengaluru's roads reveals a disproportionately high share of two-wheelers, with the share of cars also rising steadily. This trend underscores the inadequacy of the existing public transport system. Volume-to-Capacity (V/C) ratios on most arterial roads exceed 1.0, indicating oversaturation. The overall average traffic speed during peak hours is approximately 13.5 kmph, reflecting severe congestion and inefficiency in the transport network.

These conditions highlight the urgent need to augment road capacity while simultaneously planning and implementing high-capacity mass transit systems along critical corridors. The proposed Elevated Corridor Project from Old Madras road from Swami Vivekananda Metro Station to Silk Board Junction on Hosur road is a strategic intervention aimed at addressing these challenges, improving mobility, and supporting the sustainable growth of Bengaluru.

1.3 Project road

The proposed corridor from Swami Vivekananda Metro Station to Silk Board Junction, via Ejipura – Koramangala–Madiwala–HSR Layout, falls within the Koramangala Planning District, located south of Bengaluru's Central Business District. This district is characterized predominantly by residential areas such as Koramangala Layout and HSR Layout, along with public, semi-public, and unclassified land uses.

The stretch from Madiwala to Old Madras Road via Domlur serves as one of Bengaluru's major traffic corridors. It connects South and East Bengaluru, passing through key commercial and residential hubs including Madiwala, Koramangala, Domlur, and Indiranagar, before reaching Old Madras Road. This corridor experiences severe congestion, particularly during peak hours, due to several contributing factors:

Key Factors Driving Congestion

1. **High Volume of Commuter and Commercial Traffic**

The corridor caters to a large number of office-goers, linking major business hubs in Koramangala, Domlur, and Indiranagar. With numerous IT companies, commercial establishments, and retail outlets along the route, traffic remains consistently heavy, peaking during morning and evening commute hours.

2. **Stop-and-Go Movement**

Heavy traffic volumes, frequent signals, and pedestrian crossings result in stop-and-go movement throughout the stretch. This pattern is especially evident near major intersections such as Sony World Junction and the Domlur Flyover.

3. **Peak Hour Delays**

Congestion is most severe between 8–11 a.m. and 5–8 p.m. Travel times increase significantly on Fridays and during rainy weather, when traffic slows further.

Potential Interventions

• Improved Signal Coordination

Deploying adaptive traffic signals that respond to real-time traffic conditions could ease congestion, particularly at critical intersections like Sony World Junction and Domlur Flyover.

• **Expansion of Metro Connectivity**

Extending metro services along this corridor would provide a reliable alternative to private vehicles, reducing road traffic volumes.

- **Elevated Corridor Benefits**

By diverting through-traffic to an elevated structure, surface-level congestion can be reduced. This would minimize idling time, improve fuel efficiency, and lower emissions, thereby enhancing air quality in densely populated areas such as Koramangala and Domlur.

1.4 Development of Project Road

1. The Koramangala Planning District lies within the inner core of Bengaluru. It covers an area of 3,083.02 hectares (30.83 sq. km) and comprises nine BBMP wards:

a) Bangalore East Zone: Agaram (Ward 114), Neelasandra (116), Shanthi Nagar (117), Vannarpet (115)

b) Bangalore South Zone: Adugodi (147), Ejipura (148), Koramangala (151), Jakkasandra (173)

c) Bommanahalli Zone: HSR Layout (174)

2. Land Use and Employment

a) The district's major employment base is commercial, encompassing both retail and office spaces.

b) Small clusters of industrial activity exist in Adugodi, Ejipura, and Koramangala wards.

c) Prominent markets and commercial centers include the Koramangala BDA Complex, Sony World Junction, Madiwala Market, and HSR Layout BDA Complex.

3. Economic and Social Profile

Koramangala and its surrounding neighborhoods have evolved into a vibrant start-up hub, attracting IT offices and entrepreneurial clusters due to their proximity to the Central Business District and Electronic City. The area also hosts a large number of restaurants, eateries, and retail outlets, with commercial development concentrated along several arterial roads.

4. Traffic and Connectivity

Traffic congestion is a pressing issue in this district, with severe bottlenecks at:

a) Silk Board Junction

b) Madiwala Check Post

c) Ejipura

d) Shoolay Circle

e) Sony World Junction

Despite these challenges, the district is well-served by BMTC bus services. The upcoming Phase 2 Metro along Hosur Road and the Outer Ring Road is expected to significantly strengthen the public transport network and ease congestion. Proposed metro stations within the district include:

- Hosur Road Corridor: Silk Board, HSR Layout
- Outer Ring Road Corridor: Venkatapura, Agara Lake, Ibbaluru

1.5 Proposal for Project Road Development

The project under consideration involves the construction of an Elevated Corridor from Old Madras Road (Swami Vivekananda Metro Station) to Silk Board Junction on Hosur Road, passing through Indiranagar, Domlur, and Madiwala. This corridor is a critical link, facilitating traffic flow between the eastern and southern parts of Bengaluru.

Existing Traffic Conditions

a. Travel Speeds: Average vehicular speeds along this corridor range between 20–25 km/h throughout the day, with frequent traffic jams.
b. Junction Delays: The corridor includes about three major junctions, where waiting times and vehicle queues during peak hours are particularly high.
c. Pedestrian Activity: Pedestrian volumes are significant along the project road, especially near areas with dense commercial activity, further contributing to delays and safety concerns.

Need for Intervention

To ensure the free flow of through-traffic along this vital route, it is necessary to construct an elevated corridor. This intervention will:

a. Relieve congestion at the surface level.
b. Reduce delays at junctions.
c. Improve overall travel efficiency and safety for both vehicles and pedestrians.

1.6 Project Location and Salient Features

The proposed project road, extending from **Swami Vivekananda Metro Station on Old Madras Road to Silk Board Junction on Hosur Road**, is situated in the **southeastern part of Bengaluru**. The **location of the project road is illustrated in Figure 1-1 below**.

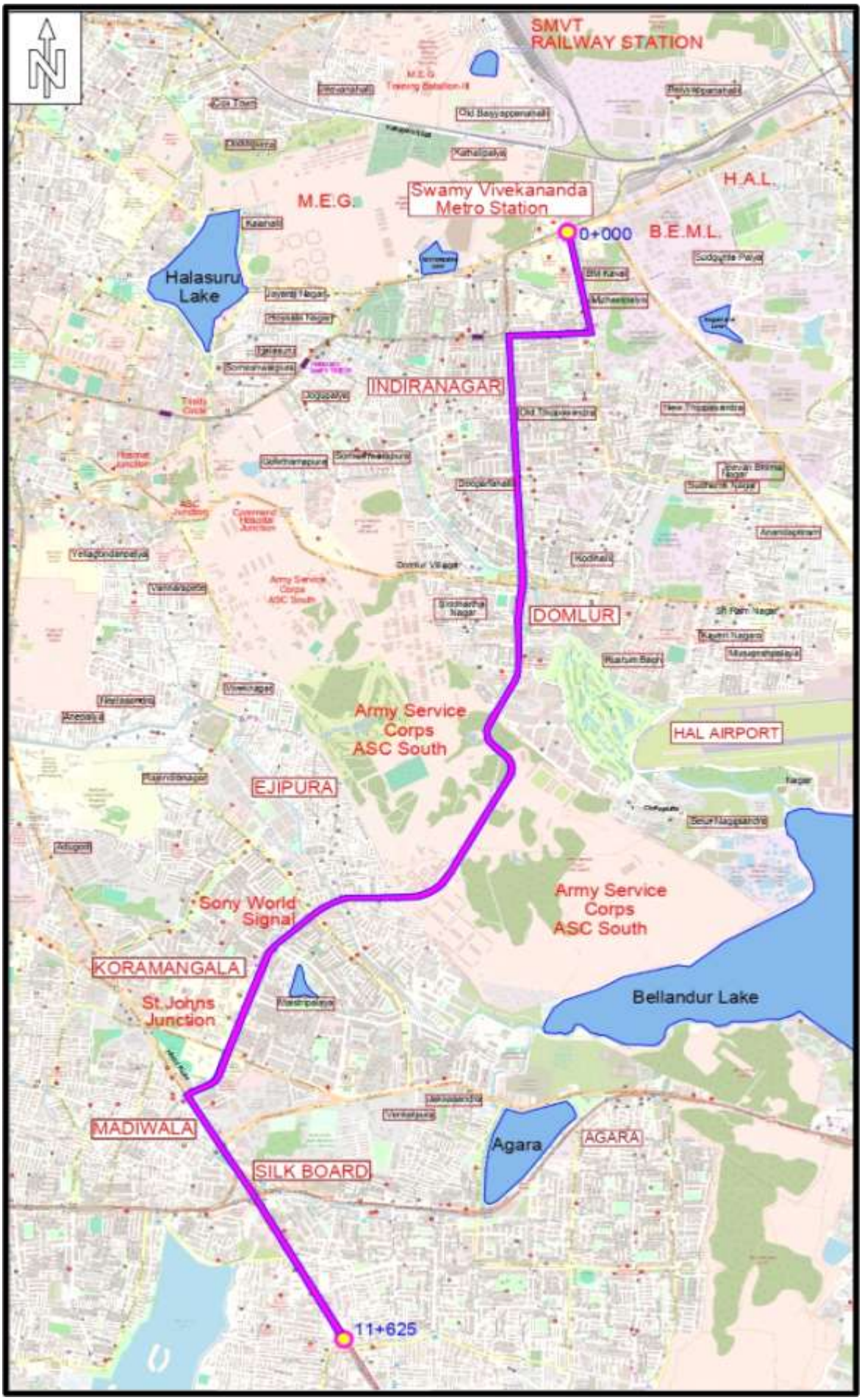


Figure 2-1Route Map Showing Location of Project Road

Salient Features

Description	Details
Name of Project	Construction of Proposed Elevated Corridor from Old Madras Road from Swami Vivekananda Metro Station to Silk Board Junction on Hosur Road via Indiranagar –Domlur- Madiwala.
Budget Head	1. Brand Bengaluru 2. Budget 2025–26, Dated: 7th March 2025, Urban Development, Sl. No. 283 (ii), Page No. 79 3. Subject No. 448/2024–25
Assembly Constituency	1. C.V. Raman Nagara, 2. Shanthi Nagara 3. Mahadevapura 4. B.T.M. Layout
Parliamentary Constituency	1. Bengaluru Central 2. Bengaluru South
Implementing Authority	**Office of the Director (Technical),** Bengaluru Smart Infrastructure Limited (B-SMILE), #108, 1st Floor, GBA, Annexe–2 Building, N.R. Square, Bengaluru – 560002.
Consultant	Siddi Shakthi Projects, No. 93/31, Asha Nivas, T.G. Layout, Ittamadu, Banashankari 3rd Stage, Hosakerehalli Post, Bengaluru – 560085
Length of Existing Road	11.625 km
Length of Proposed Elevated Corridor (including approaches)	The total length of the proposed elevated corridor is 13.049 km, which includes: • Part of four-lane section • Single-lane section • Ramps When converted to a four-lane equivalent, the effective length is 8.325 km.
Total Project Cost	₹ 1300.00 Crores
Amount Put to Tender	₹ 852.00 Crores

Description	Details
Provisions in the Estimate	
GST @ 18%	₹ 153.36 Crores
Contingencies and Provision for Departmental Establishment Charges @ 1.90 % on APT	₹ 16.19 Crores
Independent Engineer / PMC/DPR @ 1.50% on APT	₹ 12.78 Crores
Price escalation @ 2.5% for the 2nd year	₹ 21.30 Crores
Provision for utility shifting @ 8% on APT	₹ 68.16 Crores
Arboriculture/Afforestation @ 0.5% on APT	₹ 4.26 Crores
Land Acquisition Cost including Structures	₹ 171.38 Crores
Miscellaneous and other Departmental Deposits	₹ 0.56 Crores
Total Project Cost	₹ 1300.00 Crores
Cost of Structures in terms of Area / Km	
Total Structural area	111572.9 Sqmt
Cost / Sqmt	₹ 70474.00
Cost / Sqmt on APT	₹ 72913.00
Cost / Sqmt on TPC	₹ 111251.00
Cost / Km on APT	₹ 65.29 Crore
Cost / Km on TPC	₹ 99.62 Crore
Project Duration	24 Months (Including Monsoon)

Description	Details
Schedule of Rates	Common Schedule of Rates 2023-24, Issue Rate for 2025-26, Dated: 08-10-2025 & 06-01-2026.
Area Weightage	10% is adopted as per Schedule of Rates PWD 2023-24 within GBA limit.
Overhead Charges	10% is adopted for concrete work as per Schedule of Rates PWD 2023 - 24 Volume - 1 for Bridge work.
Major Connecting Road	1. Old Madras Road (Swamy Vivekananda Metro Station) 2. Indiranagara 80 Feet Road 3. Indiranagara 100 Feet Road 4. Chinmaya Mission Hospital (CMH) Road 5. HAL Old Airport Road 6. Ejipura Main Road 7. Srinivagilu Main Road (Sony World Signal) 8. Sarjapura Main Road 9. Madiwala Main Road 10. Hosur Main Road
Existing Public facility	1. SwamyVivekanda Metro Station 2. Baiyyappanahalli Metro Station 3. K.R. Puram Railway Station 4. Sir M. Visvesvaraya 3rd Terminal Railway Station 5. Isolation Hospital 6. Sir. C.V. Raman General Hospital 7. Chinmaya Mission Hospital (CMH) 8. Indiranagara Metro Station 9. HAL Airport 10. Domlur BMTC Depot 11. ST. John's Medical College & Hospital 2. Madiwala Market 13. Survey of India Karnataka Geo-Spatial Data Centre 14. Central Silk Institute 15. Electronic City
Zone	1. East, 2. Mahadevapura, 3. South

Description	Details
Ward No. and Name	1. 58 - New Thippasandra 2. 80 – HoysalaNagara 3. 89 – JoguPalya 4. 112 – Dommaluru 5. 88 – JeevanBheemaNagara 6. 113 – KoneneAgrahara 7. 150 – Bellanduru 8. 114 – Agaram 9. 148 – Ejipura 10. 151 – Koramangala 11. 152 – SuddaguntePalya 12. 172 – Madiwala 13. 173 – Jakkasandra
District	Bengaluru Urban
Taluk	: 1. Bengaluru East 2. Bengaluru North 3. Bengaluru South
Hobali	1. Mahadevapura 2. K.R. Puram 3. Marathahalli 4. Beguru
Revenue Villages	1. BinnamangalaManavarthiKaval 2. ThippasandraManavarthiKaval 3. Binnamangala 4. Thippasandra 5. Dukanahalli 6. Kodihalli 7. Dommaluru 8. Chellaghatta 9. Shinivagilu 10. Ejipura 11. Jakkasandra **12.** Madiwala
Type of Soil	Sandy Clay
Climate	Temperature - 28^{O} to 32^{O} Humidity - 60 % Wind Speed - 19 Kmph Rain Fall - 970mm

Description	Details
Seismic Zone	Zone II (Least Active Zone)
Survey of India Topo Sheet No.	New No. D43X9 and Old No. 57 H/9
RMP – 2015 map No.	1. 2.18 Map (a) C.V. Raman Nagara 2. 2.06 map (a) Indira Nagara 3. 2.06 map (b) Indira Nagara 4. 2.07 un classified & 2.08 Koramanagala Map (b) 5. 2.07 un classified & 2.08 Koramanagala Map (a) 6. 2.09 Map (b) Shanthinagara 7. 2.10 Map (b) Jayanagara 8. 3.18 Map (a) Begur
Existing ROW width	24/30/45m
Width as per RMP-2015	24/12/45
Design considerations	Design speed - 40 to 60 kmph Design traffic - 10 msa Design life - 100 years Design CBR - 10 %
Lead Location	Hennur Bande Quarry (Kannur Village), Total Distance From centre of Project alignment to Hennur Bande is 25Km
Total Length of Existing Road	11.625 Km as per Survey
No of Cross Roads	108 Nos (RHS & LHS)
No of Traffic Signals	13 Nos
No of Bus Stops	46 Nos
Traffic Capacity	The present peak hour traffic / hour is estimated for this Project is 3996 and 12064 is estimated for next 25 years i.e at 2050.
Number of Lane	2/3/4 Lanes
Minimum Carriageway Width	2/3/4 x 3.5 m
Merging and Diverging lane Taper length	200.0m

Description	Details
Crash Barrier	2 x 0.5m
Total width of Structure	7.0m/8.5m/12.0m/17.2m
Minimum Vertical Clearance	5.5m (Varies as per site condition)
Minimum Radius of Curve	70m
Viaduct Span for straight reach	45m
Viaduct Span at Curve location	35m
Viaduct span for 8.5m Carriage Way	35mwith cantilever pier cap
Vertical clearance for second level structure	4.5m/5.5m
Supporting structure at split section / wider	Portal frame with UHPFRC I Girder as beam
Type of Box Girder	Segmental UHPFRC U Girder
Foundation	Deep Pile foundation
Type of Box Girder	Segmental UHPFRC U Girder
Entry / Exit Ramp	with RE Wall approach
Features of Elevated Rotary at Madiwala T Junction	
Proposed Location	Madiwala T Junction at Chainage: 8+782
Number of Lane	4 lanes unidirectional
Total width of Elevated Rotary	15.0m
Minimum Carriageway Width	4 x 3.5 m
Crash Barrier	2 x 0.5m
Minimum Vertical Clearance	5.50m
Radius of the Rotary	36.0m
Overall Radius of the Rotary	51.0m
Circumferential length at C/L of Rotary	157.0m
Shape of Box Girder	Strutted Box Girder UHPFRC

Description	Details
Additional provisions in corridor	1. End to End Connectivity 2. Entry and Exit at suitable locations 3. Installation of Flexible Median at regular interval for traffic diversion during emergency. 4. Installation of Variable Message Signs (VMS) to manage traffic and provide real time information to the road users. 5. Installation of automatic traffic count machine. 6. Integrating existing and ongoing flyover for Entry/exists
At grade improvement	The restoration of White thin topping and reconstruction of CC pavers along with foot path pavers is included in the estimate. Apart from this reconstruction of road on approaches Hosur near St. Jhon property and on Sarjapura Road in the premises Survey of India office. Further the entire flexible area of the pavement along the corridor from Old Madras Road to Begur Road junction of 11.625Km is proposed for overlay of 40mm Bituminous Concrete (BC) and 60mm of Dense Bituminous Concrete (DBM) used for profile correction to correct the undulations including desilting of the existing drain with repairs at damaged locations.
Utility relocation	Utilities such as Water Supply and sewage lines (BWSSB), High Tension Power Line of 11 KV (BESCOM / KPTCL), GAS Pipeline/OFC are found in the corridor. After consultation with concerned stake holders a lump sum provision of 8% on the cost of Amount put to tender is reserved for shifting/reconstruction of Utilities falling within the project corridor.

DETAILS OF PROPOSAL FOR THE PROPOSED ELEVATED CORRIDOR

SI. No.	Description	Chainage		Length in Km	Width in m
		From	To		
1	Indiranagara from Rotary along 80feet road via 100ft road Length of Approach=100m ,Length of Viaduct = 2825m	0+100	2+925	2.825	12.00
2	Down ramp to Indiranagara at Rotary junction near C V Raman General Hospital Length of Approach=100m ,Length of Viaduct = 110m	0+100	0+310	0.210	7.00
3	Down ramp to Old madras road at Rotary junction near C V Raman General Hospital Length of Approach=100m, Length of Viaduct=150m	0+107	0+357	0.250	5.50
4	from chainage 2+575 to 3+587 to cross existing Domlur interchange including taper length of 150m &2 m additional length due to double level Length of Approach = 100m, Length of Viaduct = 914m	2+575	3+587	1.014	7.00
5	up ramp from Sarjapura Approach including tapering of 150m Length of Approach = 100m, Length of Viaduct = 240m	0+000	0+190	0.340	7.00
6	Ejipura to Madiwala rotary (LHS+RHS) 360.5X2=721m Length of Viaduct = 721m	8+368	8+728	0.721	8.50
7	Proposed Audgodi loop INCLUDING 7 M & 17.2 M Carriageway (LHS+RHS) + TAPERING 2 X 120M Length of Viaduct = 960m & 202m	0+000	0+360	0.960	7.00
		0+360	0+562	0.202	17.2
8	Audgodi loop to Silk board continued Length of Viaduct = 120m	0+562	0+682	0.120	7.00
9	Tunnel approach connecting to Audgodi loop170m with tapering length of 120m Length of Approach = 80m, Length of Viaduct = 210m	290m		0.290	7.00
10	Double deckar flyover from Banashakari to Madiwala junction including taper length of 120m+30m of joint connecting at ch 270 Length of Viaduct = 634m	634m		0.634	7.00
11	From Rotary to Hosur crossing Double deck flyover towards Hosur , HSR Layout 200m and Hosur to Madiwala side	8+782	9+766	2.011	7.00
12	8+782.5 to 8873 (LHS) 90m+RHS 878.25 towards Masjid -90m Length of Viaduct = 180m	2078m		0.180	7.00
	8+873 TO 9191 Length of Viaduct = 318m			0.318	7.00
	Double level from 9+766 TO 9191 (LHS+RHS)= 575 X 2+ add 2m for additional length due to double level Length of Viaduct = 1152m			1.152	7.00
	from ch 9561 -Towards HSR road loop 200m + taper length of 150m Length of Viaduct = 350m			0.350	7.00
13	Rotary at Madiwala junction Length of Viaduct = 157m	157m		0.157	15.00
14	Flyover from Silk Board to Electronic city flyover Ch 9820 to 10975+ taper length on either side with 120m Length of Viaduct = 1395m	9+820	10+975	1.392	8.50

SI. No.	Description	Chainage		Length in Km	Width in m
		From	To		
15	Electronic city to Banashankari double deckar Ch 0.00 to 1591+tapering of 120m length at start and end	0+000	1+591	1.831	8.50
Total length of Elevated Corridor				**13.049 Km**	
Total length of Approach				**580.00m**	
Total Length of Viaduct				**12469.00m**	
Total area of Viaduct				**102691.0Sqm**	
Total Area of Approach				**4410.0Sqm**	

Design standards and other references

- IRC: 5 General Features of Design.
- IRC: 6 Loads and Stresses.
- IRC: 15 Construction of Concrete Roads.
- IRC: 18 DESIGN Criteria for Pre-Stressed Concrete Road Bridges (Post-Tensioned Concrete).
- IRC SP 19 Manual for Survey, Investigation and Preparation of Road Projects.
- IRC: 21 Standard Specifications and Code of Practice for Road Bridges.
- IRC: 22 Composite Construction (Limit State Design).
- IRC: SP: 23 Vertical Curves for Highways.
- IRC: 24 Steel Road Bridges.
- IRC: 35 Road Markings.
- IRC: SP: 37 Guidelines for Evaluation of Load Carrying Capacity of Bridges.
- IRC: 37 Design of Flexible Pavements.
- IRC: 38 Design of Horizontal Curves for Highways and Design Tables.
- IRC: 39 Standards for Road-Rail Level Crossing (I Revision).
- IRC: SP: 42 Road Drainage.
- IRC: 44 Cement Concrete Mix Design for Pavements.
- IRC: SP: 50 Urban Drainage.
- IRC: 54 Lateral and Vertical Clearances at Underpasses for Vehicular Traffic.
- IRC: SP: 56 Steel Pedestrian Bridges.
- IRC: SP: 57 Quality Systems for Road Construction.
- IRC: 58 Design of Plain Jointed Rigid Pavements for Highways.
- IRC: 65 Recommended Practices for Traffic Rotaries.
- IRC: 67 Road Signs.
- IRC: 71 Abbreviations and Symbols in Documents and Plans.
- IRC: 78 Foundation and Substructure.
- IRC: 79 Road Delineators.
- IRC: 83 (Part I) Metallic Bearings.
- IRC: 83 (Part II) Elastomeric Bearings.
- IRC: 83 (Part III) POT, POT cum PTFE, PIN and Metallic Guide Bearings.
- IRC: 86 Geometric Design Standards for Urban Roads in Plains.

- IRC: SP: 90 Manual for Grade Separators and Elevated Structures.
- IRC: 92 Designs of Interchanges in Urban Areas.
- IRC: 103 Pedestrian Facilities.
- IRC: 112 Concrete Road Bridges.
- IS: 2911 (All Parts) Pile Foundations.
- Designs and drawings of Flyover from IndoraChowk to DighoriChowk in Nagpur (NHAI)
- Circular for use of UHPFRC by MORT&H, Government of India, File No. RW/NH-33049/101/2020-S&R (B) Pt, Dated 22-02-2022.
- Guideline for use of UHPFRC [File No. RDSO-BNSOESTR (CB-1)/5/2020-O/o ED/Structures/RDSO, Dated: 08-0-2024 (CBS/PCB report No. BS-136),] by Ministry of Railway, Government of India, Research Design and Standards organization, Lucknow-226011.
- Comprehensive Mobility plan.
- Survey of India Topo sheets
- Survey of India GTS Bench Mark.
- References of other similar projects.
- PWD Common schedule of Rates Karnataka 2023-24, Issue Rates, Dated: 08-10-2025.
- PWD SoR for Road and bridge Work, Government of Madhya Pradesh 11-04-2025.
- Final Feasibility Study Report, November 2024, Volume-I & 2, Altinok.
- Normative cost of Ministry of Road Transport and Highways (EAP) Zone, Government of India No: RW/NH-24036/272010-PPP, Dated: 25-04-2018 (11 pages) & 19-01-2022 (23 pages).
- Guideline Value of Bengaluru Urban District under Jayanagara Circle (CVC/99/2023-24, Dated:08-09-2023)
- Central Public Works Department (CPWD) Plinth Area Rates of 2025.

Benefits of this Project

a) **Reduced Travel Time & Delays – Faster and more reliable movement along the corridor.**
b) **Congestion Relief** – Diverts through traffic above grade, easing surface-level pressure.
c) **Improved Level of Service** – Enhances efficiency and comfort for commuters.
d) **Lower Fuel Consumption & Pollution** – Reduced idling and stop-and-go movement improve air quality.
e) **Reduced Vehicle Operating Costs** – Less wear and tear, lower maintenance expenses.
f) **Minimized Junction Delays & Conflicts** – Smooth flow across critical intersections.
g) **Enhanced Connectivity –** Better access to adjacent residential, commercial, and transit hubs.
h) **Capacity for Future Demand** – Designed to accommodate projected traffic growth.
i) **Urban Regeneration Opportunities** – Supports redevelopment and revitalization of surrounding areas.
j) **Transit-Friendly Environment** – Encourages integration with sustainable public Transport.
k) **Seamless Multimodal Transfers** – Easier shift between metro, bus, and private modes.

l) **Commercial Potential** – Unlocks land value capture and integrates existing Retail/commercial clusters.

m) **Redevelopment Integration** – Ensures rehabilitation or relocation of existing uses within the scheme.

1.7 Existing Project Road Details

The project corridor covering a total length of 11.625 km which is starting from 80 Feet Road in front of Swamy Vivekananda Metro Station on Old Madras Road passing through CMH Hospital, 100 Feet Road on Indiranagara, Domlur, Ejipura, Sony World Signal, Sarjapura Road, Madiwala connecting Silk Board Junction and Integrating existing elevated corridor (Electronic City Flyover at Begur Junction).

Road Inventory

As stated above the total length of the project road is 11.625 Km in which 108 Cross Roads (RHS &LHS) major junctions with signal is 13Nos, Bus Stops of about 46 Nos (LHS &RHS). From Chiange 0+000 to 4+428 is white topping portion from chainage4+428 to 11+625Asphalt Road. The existing width of Foot path is ranging between 3.00m to 6.00m and the existing width of RCC Drain is about 1.2 to 1.5m which is almost placed at the edge of the property line.Detailed description of the project corridor chainage wise is mentioned in the table below for better understanding of the project road.

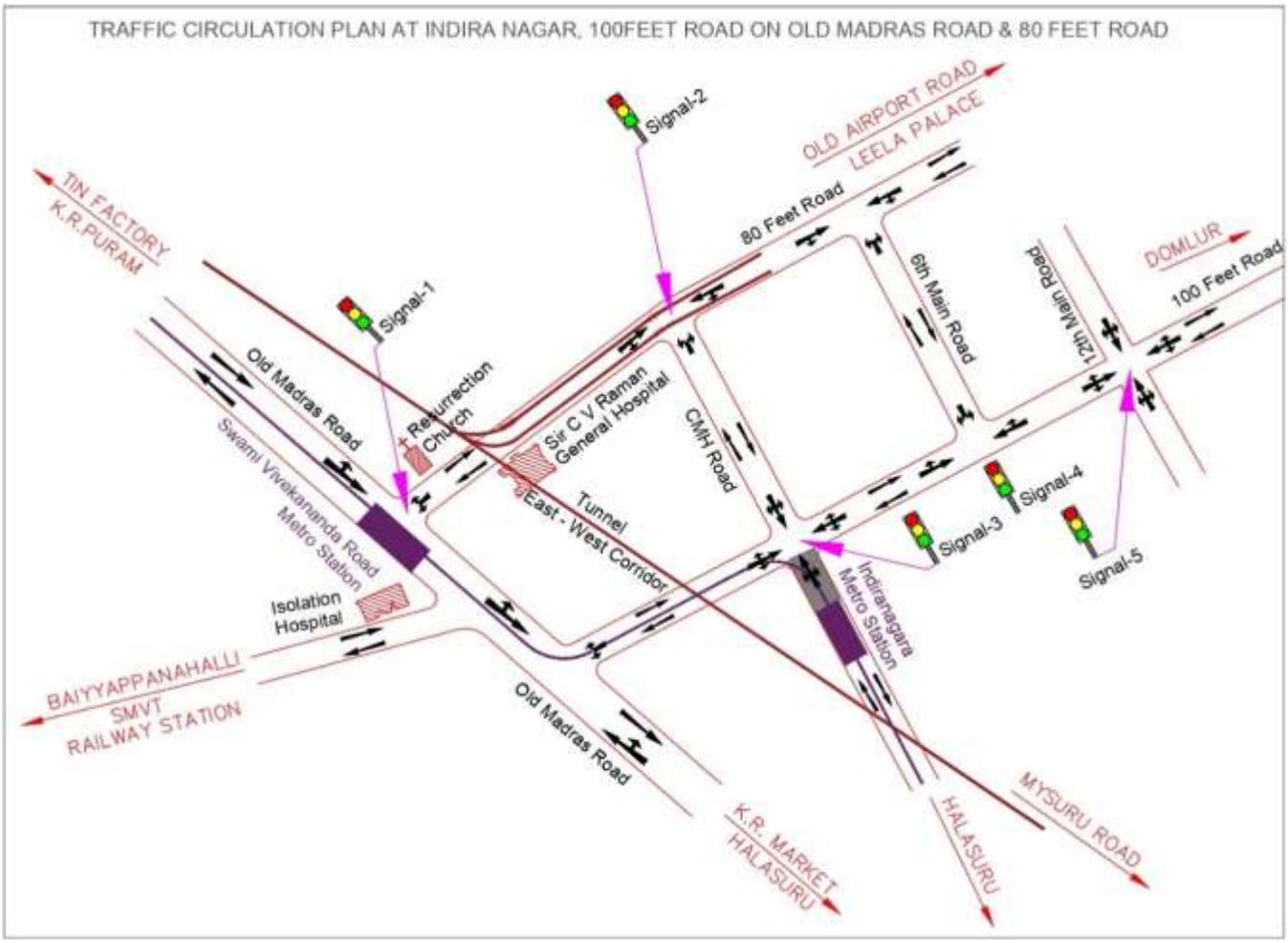
Table 2-1 Project Road Existing Right of Way details

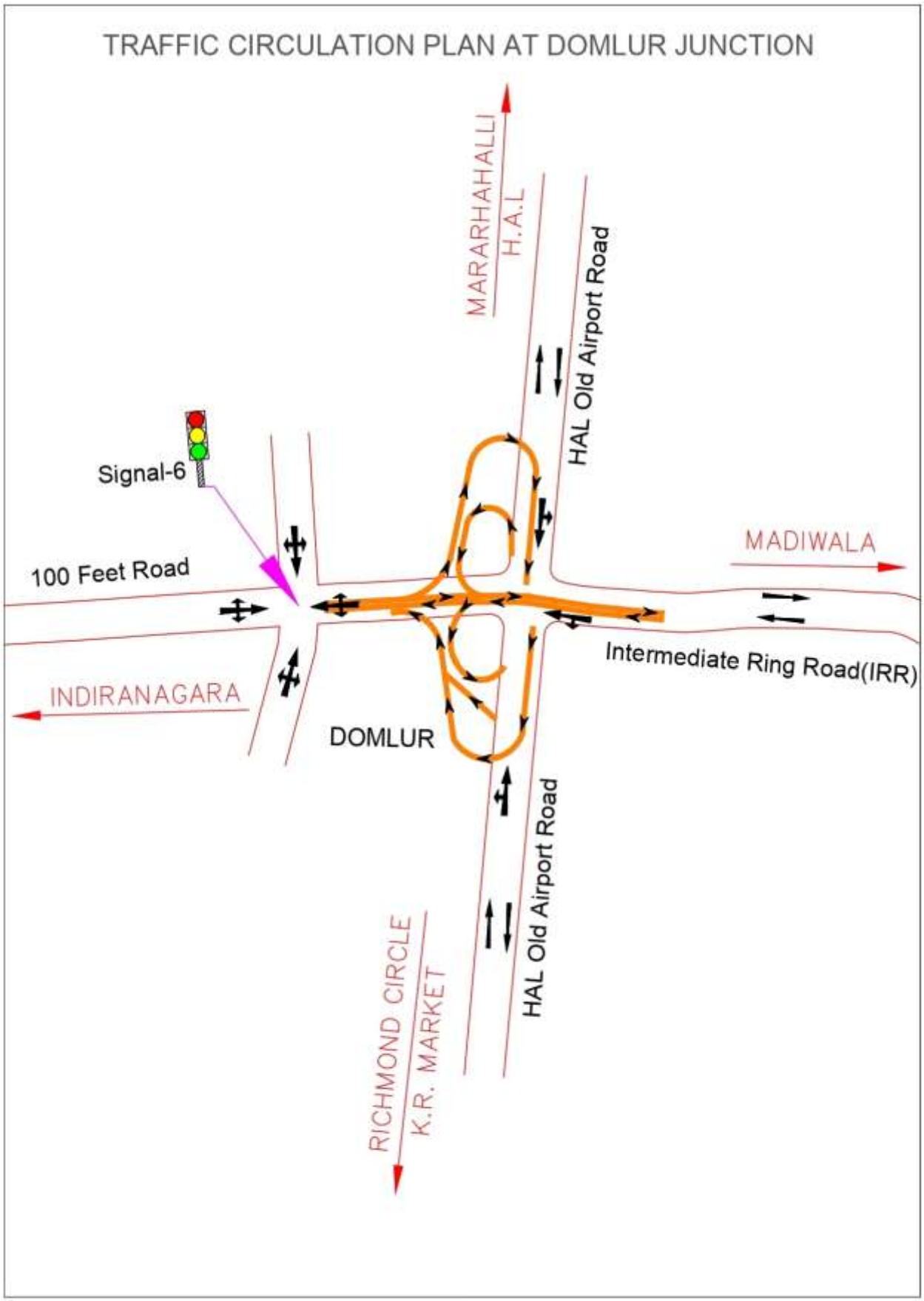
Sl. No.	Stretch	Chainage		Length in km	EROW Width in m
		From	To		
1	Swamy Vivekananda Metro Station on Old Madras Road to Chinmaya Mission Hospital (CMH)	0+000	0+800	0.800	24.00
2	Chinmaya Mission Hospital (CMH) to Indiranagara 100 Feet Road (CMH Park)	0+800	1+400	0.600	24.00
3	Indiranagara 100 Feet Road (CMH Park) to Domlur Flyover 1. Existing BMRCL Metro from SwamyVivekanada Metro Station to Indira Nagara Metro Station	1+400	3+115	1.715	30.00
4	Domlur Flyover (17m width)	3+115	3+582	0.467	33.00 to 45.00
5	Domlur Flyover to Defence Property	3+582	4+583	1.001	33.00
6	Defence Property to Start of Ejipura Flyover 1. Underpass to Defence authorities at Chainage: 5+178.00	4+583	6+125	1.542	33.00
7	Ejipura Flyover (17m width)Under Construction from Ejipura to Madiwala St. John Hospital 1. Down Ramp towards Sarjapura Road 2. Up Ramp from Sarjapura Road 3. Up Ramp from Ejipura Main Road	6+125	8+350	2.225	30.00
8	Madiwala Underpass	8-830	-	0.250	17.50
9	Madiwala (St. John Hospital) to Central Silk Board Junction	8+350	9+800	1.350	30.00 to 45.00

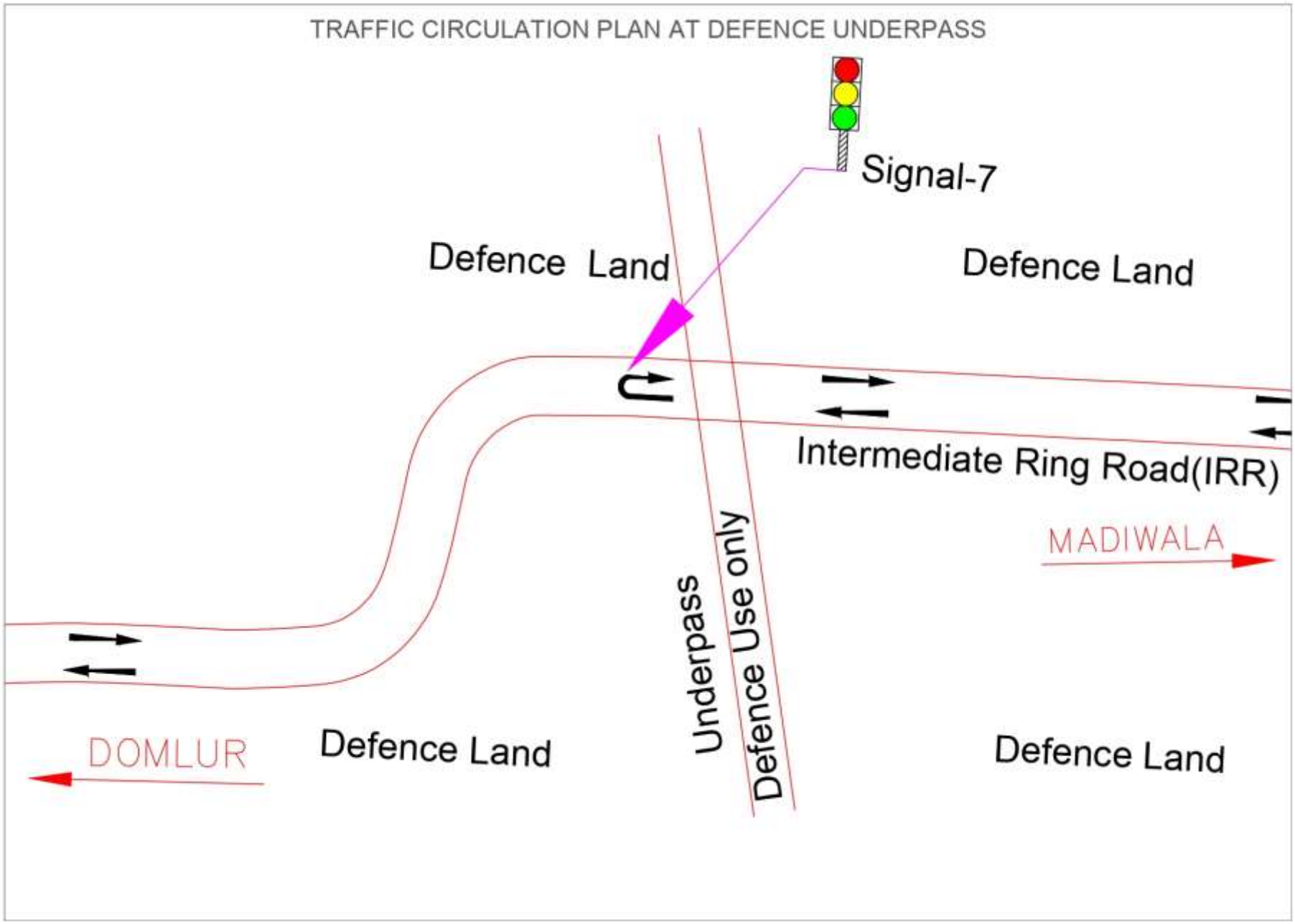
Sl. No.	Stretch	Chainage		Length in km	EROW Width in m
		From	To		
10	Central Silk Board Junction to Electronic City Flyover near Begur Road Junction 1. Double Decker Flyover from Banashankari to Silk Board with loop to Electronic City and HSR Layout 2. Double Decker Flyover from HSR layout to Banashankari. 3. BMRCL Metro from Banashankari to Electronic City. 4. BMRCL Metro from HSR Layout to Silk Board 5. Hour Road Flyover from Ch: 9+461 to 10+000	9+800	10+975	1.175	55.00
11	St. John Junction to Madiwala Junction (Hosur Road)	0+000	0+650	0.650	35.00
			Total	**11.625**	

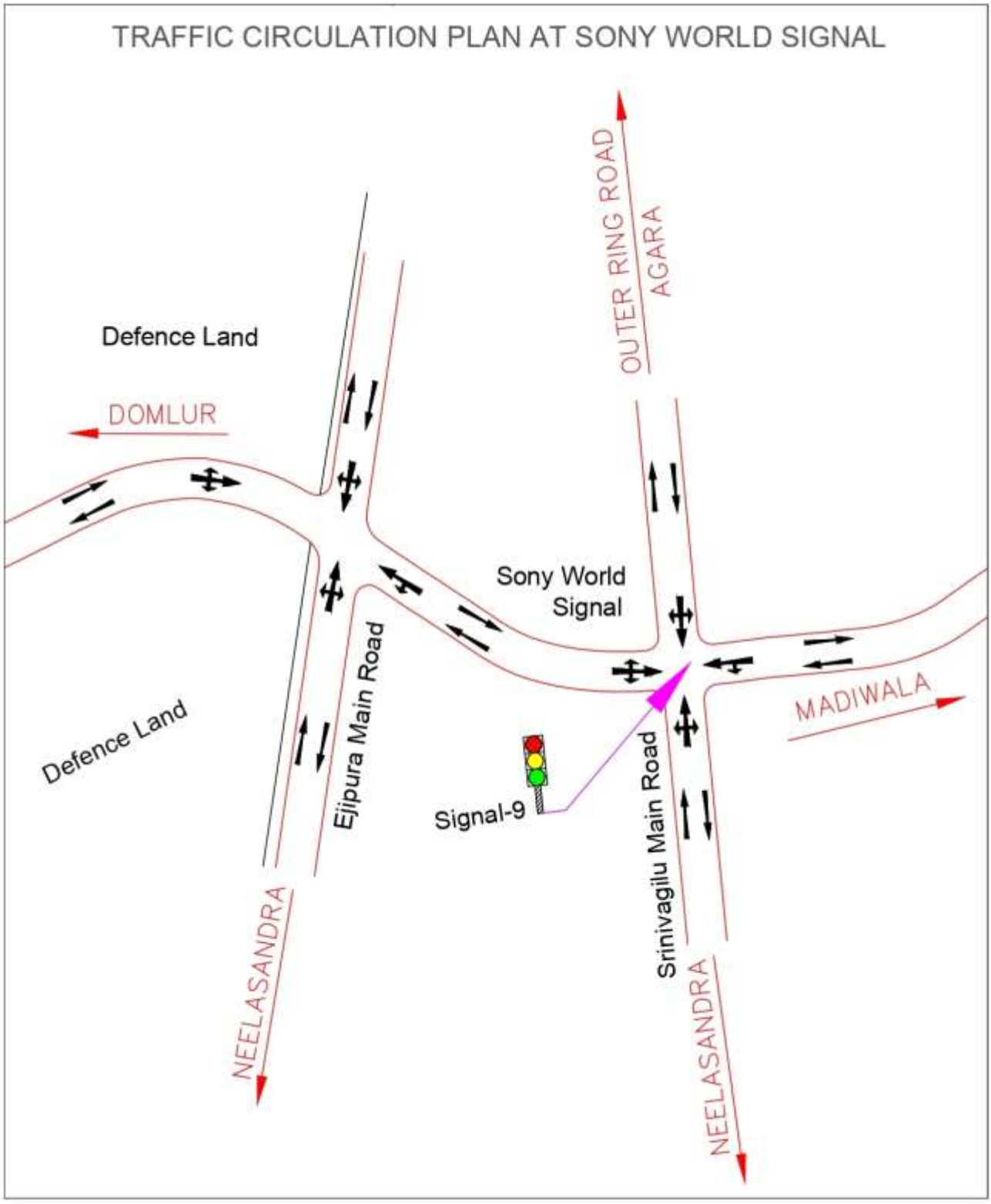
1.7.1 Present Traffic Circulation plan of Project Road

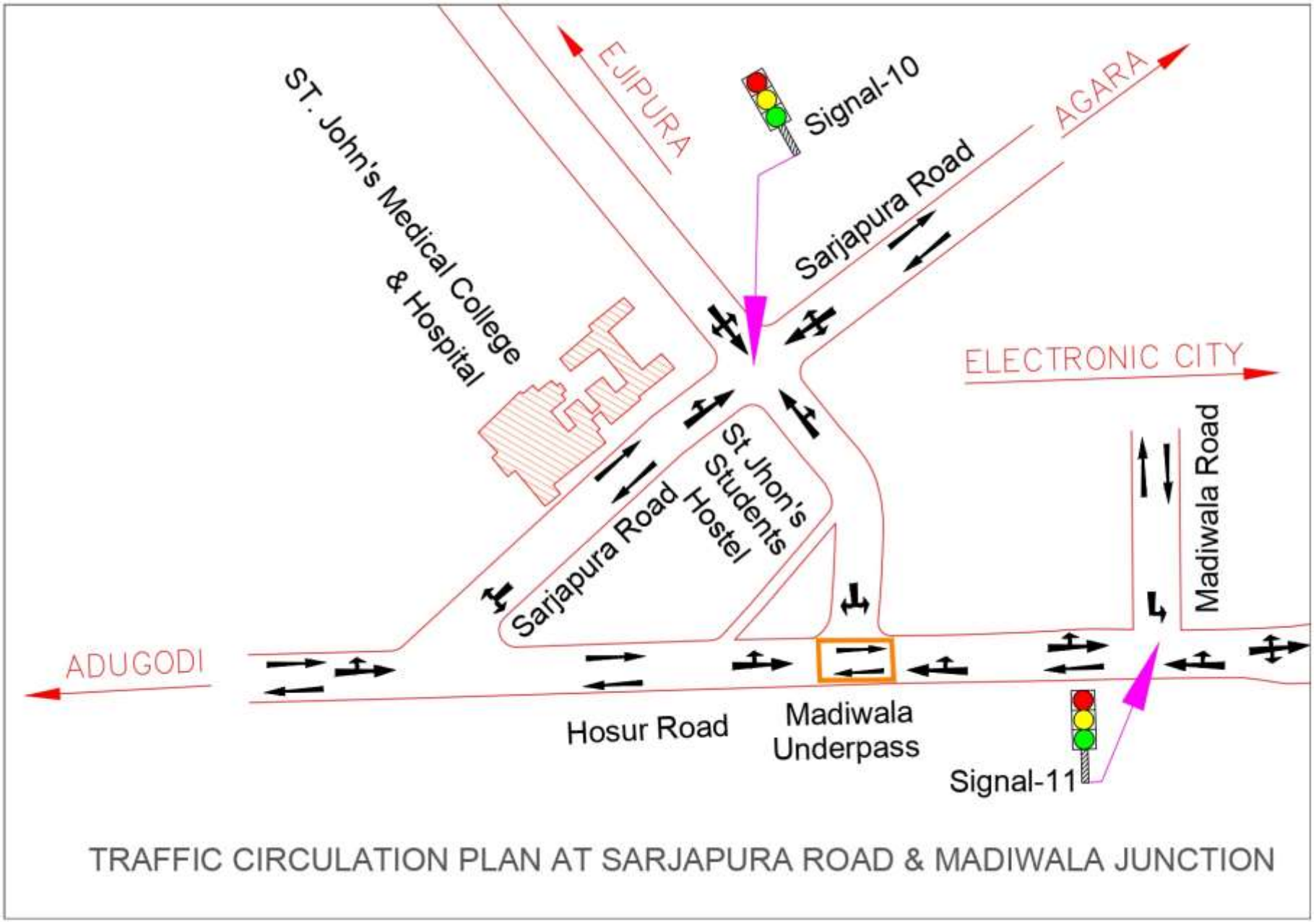
The existing traffic circulation flow of the project road is shown in Figure 2-2 Figure 2-1 below in which refers to the pattern of how vehicles currently move along the road. This includes the direction of traffic, the number of lanes, any existing intersections or traffic control measures, and understanding the current flow is crucial for planning any road improvements or new developments.




TRAFFIC CIRCULATION PLAN AT DOMLUR JUNCTION
MARARHAHALLI
H.A.L
HAL Old Airport Road
Signal-6
MADIWALA
100 Feet Road
Intermediate Ring Road(IRR)
INDIRANAGARA
DOMLUR
HAL Old Airport Road
RICHMOND CIRCLE
K.R. MARKET


TRAFFIC CIRCULATION PLAN AT DEFENCE UNDERPASS
Signal-7
Defence Land
Defence Land
Intermediate Ring Road(IRR)
MADIWALA
Underpass
Defence Use only
DOMLUR
Defence Land
Defence Land


TRAFFIC CIRCULATION PLAN AT SONY WORLD SIGNAL
OUTER RING ROAD
AGARA
Defence Land
DOMLUR
Sony World
Signal
Ejipura Main Road
Defence Land
MADIWALA
Signal-9
Srinivagilu Main Road
NEELASANDRA
NEELASANDRA



TRAFFIC CIRCULATION PLAN AT SARJAPURA ROAD & MADIWALA JUNCTION

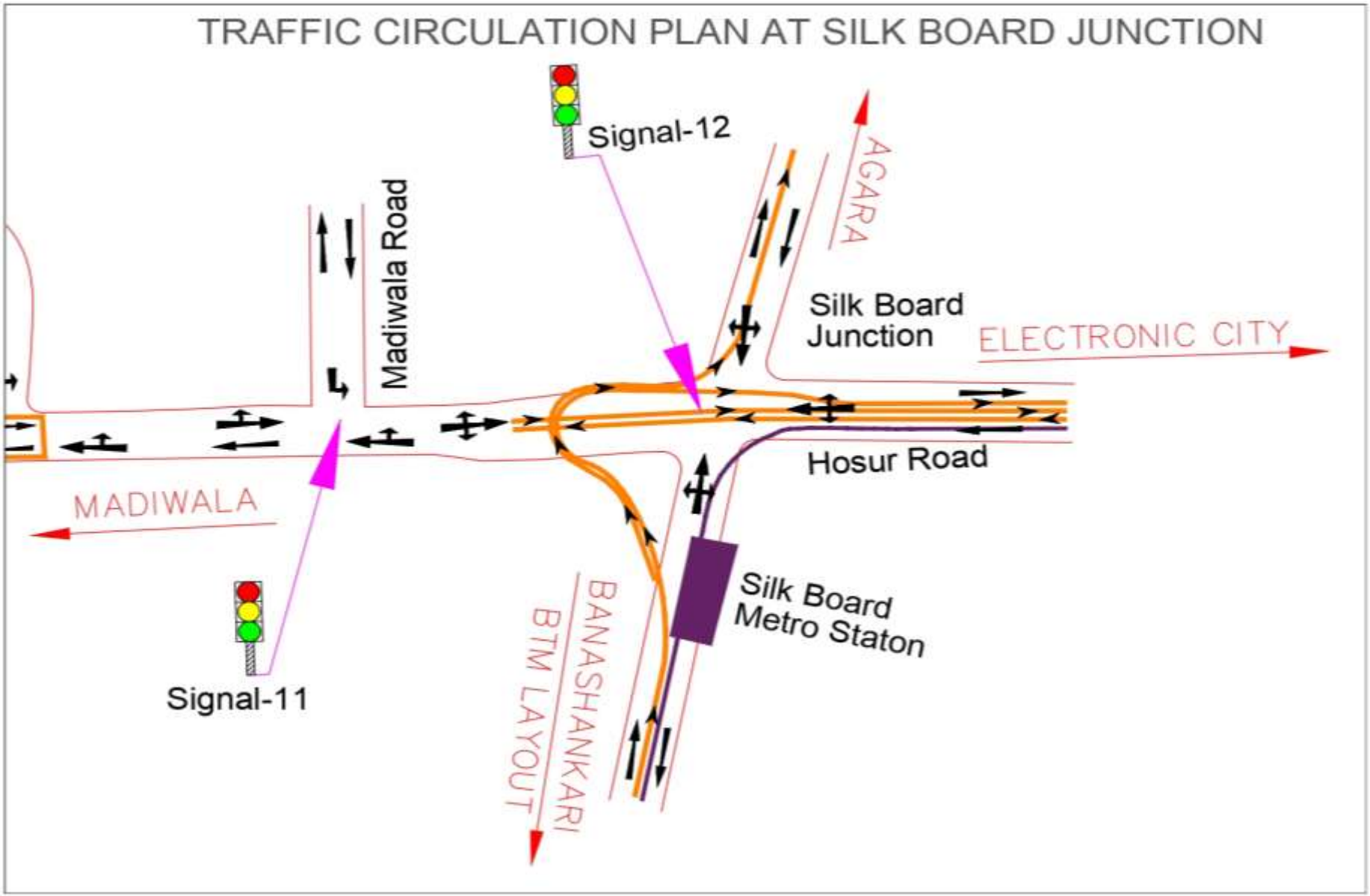


Figure 2-2 Existing Traffic circulation plan of Project Corrido

1.7.2 Seismic Analysis

Seismic Zone: The project site is falling within a Seismically Active Region Zone II (Least activity zone).

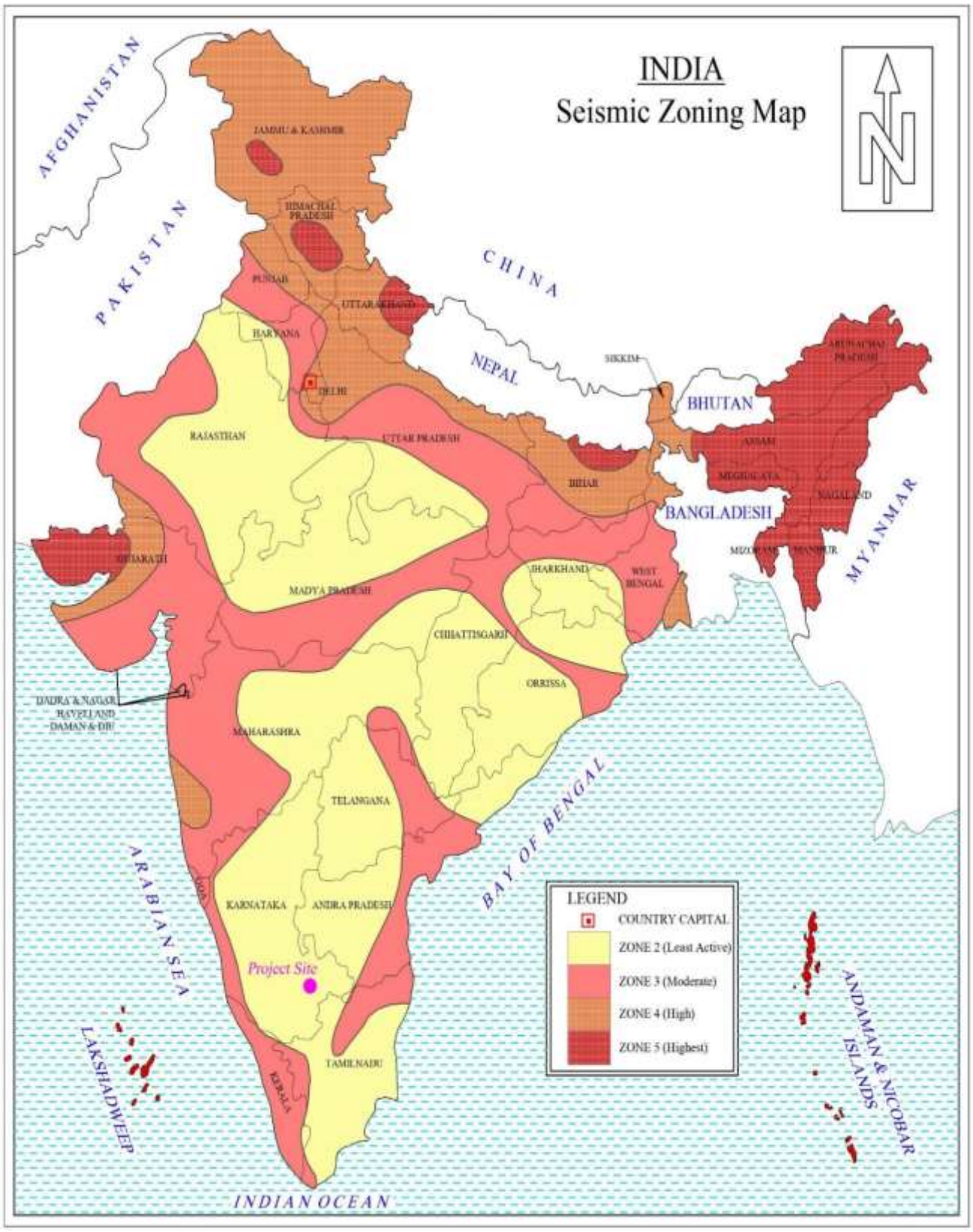


Figure 2-3 Seismic Zone Map

A seismic study would involve investigating the ground's response to seismic waves, which can be used to assess the potential for earthquake damage and guide construction in the area. While Bangalore falls under Seismic Zone II, meaning moderate earthquake risk, a seismic study can help identify areas with higher or lower risk within proposed project corridor.

Seismic Refraction Analysis:

This study use artificial seismic waves to map the subsurface layers and their properties.

- Analyzing how these waves travel through the ground, the study can determine the depth and characteristics of soil and rock layers, which can affect how they respond to earthquakes.
- This information can be crucial for understanding the potential for ground shaking and liquefaction in different parts of Proposed Project corridor.

Seismic Micro Zonation Analysis

Seismic micro zonation involves dividing an area into smaller zones based on factors like soil type, topography, and geological structure.

- Study helps to identify areas within Proposed Project corridor that might be more vulnerable to earthquake damage than others.
- For instances, areas with soft soil or unstable slopes might be identified as higher risk zones.

Ground Motion Analysis

- This studies analyze how seismic waves propagate through the ground and how they affect buildings and structures.
- This helps to estimate the ground shaking intensity in different parts of Proposed Project corridor during an earthquake.
- The results of these studies can be used to develop building codes and construction guidelines that are appropriate for the local seismic conditions.

Necessity of Seismic Analysis

- This seismic study can provide valuable information for making informed decisions about construction and infrastructure development in Proposed Project corridor.
- Understanding the local seismic conditions, it is possible to mitigate the risks associated with earthquakes and ensure the safety of buildings and people.

1.7.3 Revised Master Plan (RMP-2015)

We have collected RMP-2015 map for the Proposed Project Road section and marked the project road in the RMP-2015. The details of RMP-2015 map No. width of Existing Road and width as per RMP-2015 are shown in the below table.

Sl. No.	Stretch	Chainage		Length in km	EROW Width in m	RMP Map No.	Width as per RMP-2015 in m
		From	To				
1	Old madras Road	-		-	45.00	2.18 Map (a) C.V. Raman Nagara	67.00
2	Old Madras Road to Chinmaya Mission Hospital (CMH)	0+000	0+800	0.800	24.00	2.06 map (a) Indira Nagara	24.00
3	Chinmaya Mission Hospital (CMH) to Indiranagara 100 Feet Road (CMH Park)	0+800	1+400	0.600	24.00	2.06 map (a) Indiranagara	12.00
4	Indiranagara 100 Feet Road (CMH Park) to Central Silk Board Junction	1+400	9+800	8.300	30.00 to 40.0m	2.06 map (a) &(b) Indira Nagara, 2.07 un classified & 2.08 Koramanagala Map (a) &(b), 2.09 Map (b) Shanthinagara, 2.10 Map (b) Jayanagara& 3.18 Map (a) Begur	45.00
5	Central Silk Board Junction to Electronic City Flyover near Begur Road Junction	9+800	10+975	1.175	55.00	3.18 Map (a) Begur	67.00
6	St. John Junction to Madiwala Junction (Hosur Road)	0+000	0+650	0.650	35.00	2.09 Map (b) Shanthinagara	45.00
7	HAL Airport Road	3+350		-	45.00	2.06 map (b) Indiranagara	30.00
8	Srinivagilu Road	7+000		-	24.00	2.07 un classified & 2.08 Koramanagala Map (a)	24.00
9	Sarjapura Road	8+300		-	34.00		45.00

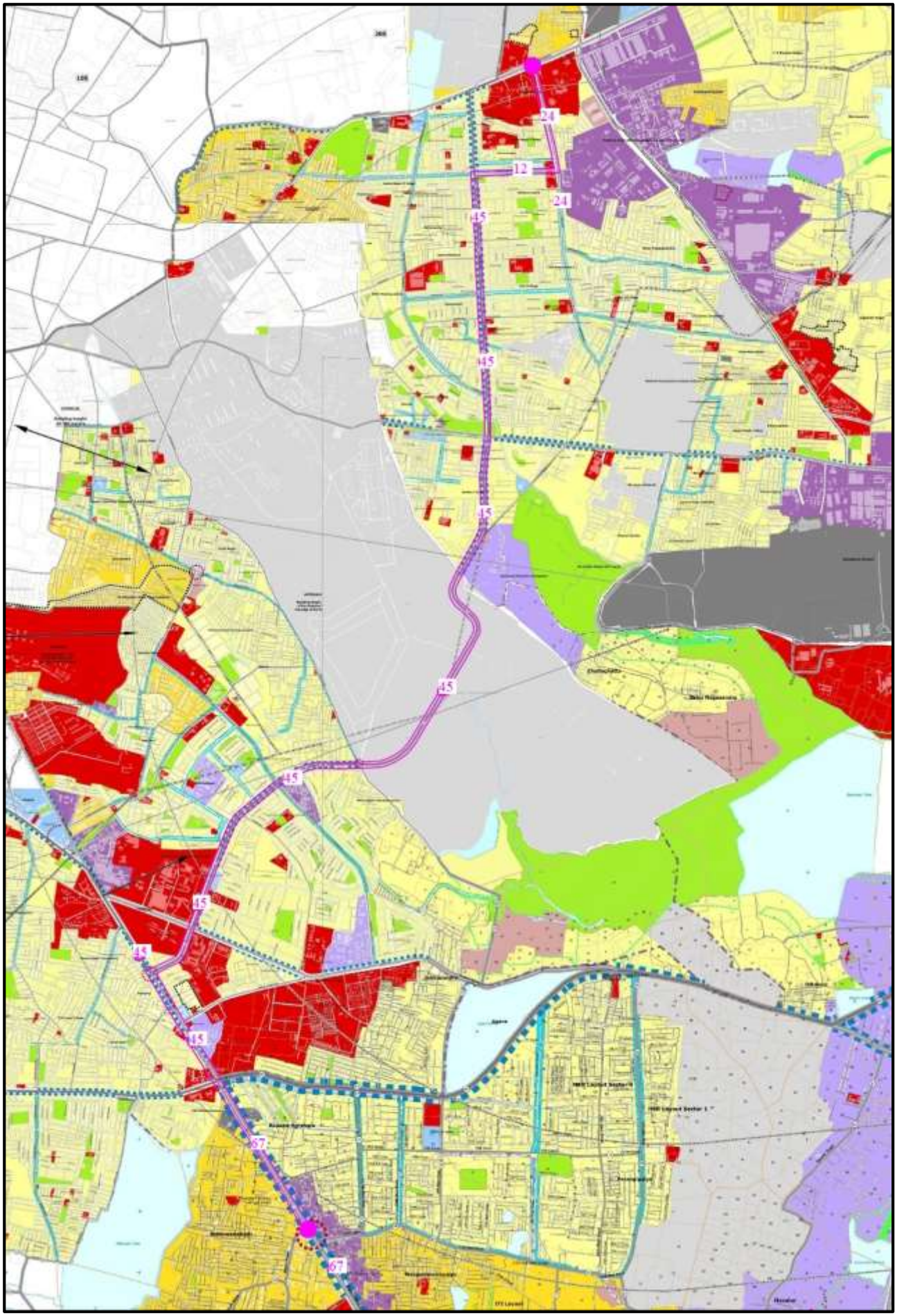


Figure 2-4 RMP-2015 Map Showing the Project Road

1.7.4 Jurisdiction

The jurisdictions of the project corridor, such as parliamentary, assembly, zone and ward, are identified with a change, as shown Table 1-2 below

Sl. No.	GBA Corporation Limit	Assembly Constituency	Parliamentary Constituency	Ward No and Name	Chainage in m	
					From	To
1	Central	CV Raman Nagara	Bengaluru Central	15 -Indranagar	0.00	2260.00
2				9- Hoysala Nagara	1360.00	1675.00
3				23- Jogpalya	1675.00	2450.00
4				20- Kodihalli	2260.00	3340.00
5				22- Dommaluru	2450.00	4428.00
6		ShanthiNagara		24 - Agaram	4428.00	6378.00
7	South	BTM Layout	Bengaluru South	27- Sri Laxmidevi	6378.00	7500.00
8				28-Kormangala East	6828.00	8368.00
9				24A- Adugodi	7500.00	7630.00
10				29- Koramangala West	7630.00	9520.00
11				20 - Madiwala	8873.00	9760.00
12				30- Jakkasandra	9760.00	10000.00
13		Bommanahalli		61- Kodichikkanahalli	10000.00	10630.00
14				63- Bommanahalli	10630.00	10975.00
15				72- HSR Layout	10000.00	10975.00

Table 2-2 Jurisdiction of the Project Road

1.7.5 Revenue Villages

There are 12 revenue villages on the project road, which are listed in Table 2-3below.

Sl. No.	District	Taluk	Hobali	Village
1	Bengaluru Urban	Bengaluru East	Mahadevapura	BinnamangalaManavarthikaval
2			K.R.Puram	ThippasandraManavarthikaval
3		Bengaluru North	Kasaba	Binnamangala
4		Bengaluru East	Marathahalli	Thippasandra
5		Bengaluru North	Kasaba	Dukanahalli
6		Bengaluru East	Marathahalli	Kodihalli
7		Bengaluru North	Kasaba	Dommaluru
8		Bengaluru East	Marathahalli	Chellaghatta
9		Bengaluru South	Beguru	Shinivagilu
10				Ejipura
11				Jakkasandra
12				Madiwala

Table 2-3 Revenue Villages of the Project Road

1.8 Objective of the Project

The key objectives of the study are as follows:

Assessment of Need – Evaluate the requirement for elevated road infrastructure along the project corridor, identify prevailing traffic problems, and ensure seamless travel in terms of connectivity, safety, and convenience.

Conceptual & Detailed Planning – Develop a detailed conceptual design and prepare the Detailed Project Report (DPR) to support the client in effective project implementation.

Mobility Enhancement – Propose actionable measures and conceptual-level designs to improve mobility along major corridors.

The elevated roads are being constructed along arterial routes in Bengaluru primarily to alleviate traffic congestion and improve overall mobility. By providing a separate, elevated roadway, these projects aim to segregate long-distance commuter traffic from local traffic, thereby enhancing overall corridor capacity.

Additionally, elevated corridors can:

- Prioritize public transport movement.
- Encourage a shift towards sustainable mobility solutions.
- Improve travel reliability and safety.
- Support long-term urban growth and economic activity.

The following sections provide a detailed overview of the advantages of constructing the elevated corridor from Sirsi Circle to Nayandahalli:

1.8.1 Advantages of the Proposed Project

a) Reduced Congestion

Elevated corridors are designed to accommodate heavy traffic flows on sub-arterial roads, particularly during peak hours, by providing additional capacity and enabling faster vehicle movement.

b) Improved Public Transport

The project aims to prioritize the movement of public transport vehicles, ensuring faster and more efficient services, thereby encouraging commuters to shift from private to public modes.

c) Augmented Road Capacity

Elevated roads add significant capacity to existing arterial corridors, allowing smoother traffic flow and reducing bottlenecks at critical junctions.

d) Enhanced Safety

By segregating traffic streams, elevated corridors reduce conflict points and minimize accident risks, creating a safer environment for both vehicles and pedestrians.

e) Sustainable Mobility

Reduced reliance on private vehicles and improved accessibility to public transport contribute to a more sustainable and transit-friendly urban transport system.

f) Economic Growth

Improved connectivity and reduced travel time stimulate economic activity, enhance productivity, and support regional growth.

g) Environmental Benefits

Better traffic flow and reduced idling lower fuel consumption, decrease emissions, and improve air quality along densely populated stretches.

1.9 Tender for Design Consultancy Services

The consultancy services for the preparation of the Detailed Project Report (DPR) for the Construction of Proposed Elevated Corridor from Old Madras Road from Swami Vivekananda Metro Station to Silk Board Junction on Hosur Road via Indiranagar –Domlur- Madiwala.have been awarded to M/s Siddi Shakthi Projects. The scope of this consultancy is limited to DPR preparation and tender processing for civil construction works.

It is important to note that this report is intended solely for conceptual planning and tender documentation purposes and shall not be referred to for detailed engineering or execution-level designs.

1.10 Objective of the Study

The primary objectives of the study are:

1. **Engineering Surveys & Investigations:** Conduct necessary engineering surveys and investigations to develop an innovative corridor design.

2. **Optimal Land Utilization:** Propose a scheme in line with Indian Road Standards, ensuring maximum use of available open land and minimizing acquisition of private property.

3. **Modern & Economical Design:** Implement the project by adopting modern concepts of innovative structural design, with emphasis on speed of construction and cost efficiency.

4. **Cost Estimation & Tender Documentation:** Prepare accurate cost estimates and comprehensive tender documents to facilitate project implementation.

1.11 Project Scope

The scope of the consultancy study involves the following:

1) Conducting Joint site inspection along with Departmental Engineers for understanding the name of road, starting, ending location of the project road and Requirements of the project.

2) Conducting Detailed Topographical survey, implementing Drone Technology and preparation and submission of final Auto CADD format Drawing showing Existing Right of Way (EROW) and Proposed Right of Way (PROW).
3) Review and study of Geotechnical Investigation.
4) Conducting Traffic Survey
5) Preparation of GAD for Project Road
6) Preliminary Structural design as per IRC Standards,
7) Preparation of Road alignment and design
8) Preparation of Estimate as per States schedule of rates
9) Preparation of Tender document for inviting tender for construction of Elevated road and related works.
10) Coordinating with Sub-Urban Rail to finalize location of piers to minimize impact on rail movement.

Detailed Project Report including above scope of work has been prepared as part of the scope.

1.12 Broad Methodology

The following broad methodology has been adopted in the present study to arrive at a viable solution for an innovative design at the railway crossing, with the objective of improving traffic flow from all directions:

1. **Traffic Flow Analysis**

Study the existing traffic circulation and anticipate future traffic demand along the corridor.

2. **Integration with Future Plans**

Review proposed developments such as Metro expansion, Suburban Railway planning, and BDA/GBA proposals to ensure coordinated planning.

3. **Adoption of Innovative Technology**

Explore modern construction technologies, including rapid construction methods and recent advancements in pre-cast structural systems, to minimize traffic disruption during execution.

4. **Road Design Improvements**

Prepare conceptual designs aimed at enhancing traffic movement and reducing congestion.

5. **Quantity & Cost Estimation**

Develop detailed quantity calculations and cost estimates for the widening and improvement scheme.

The detailed methodology adopted for the project is illustrated in a line diagram (Figure 1-5) is shown below for better understanding.

The Methodology adopted for the project is shown in a line diagram in Figure 2- below.

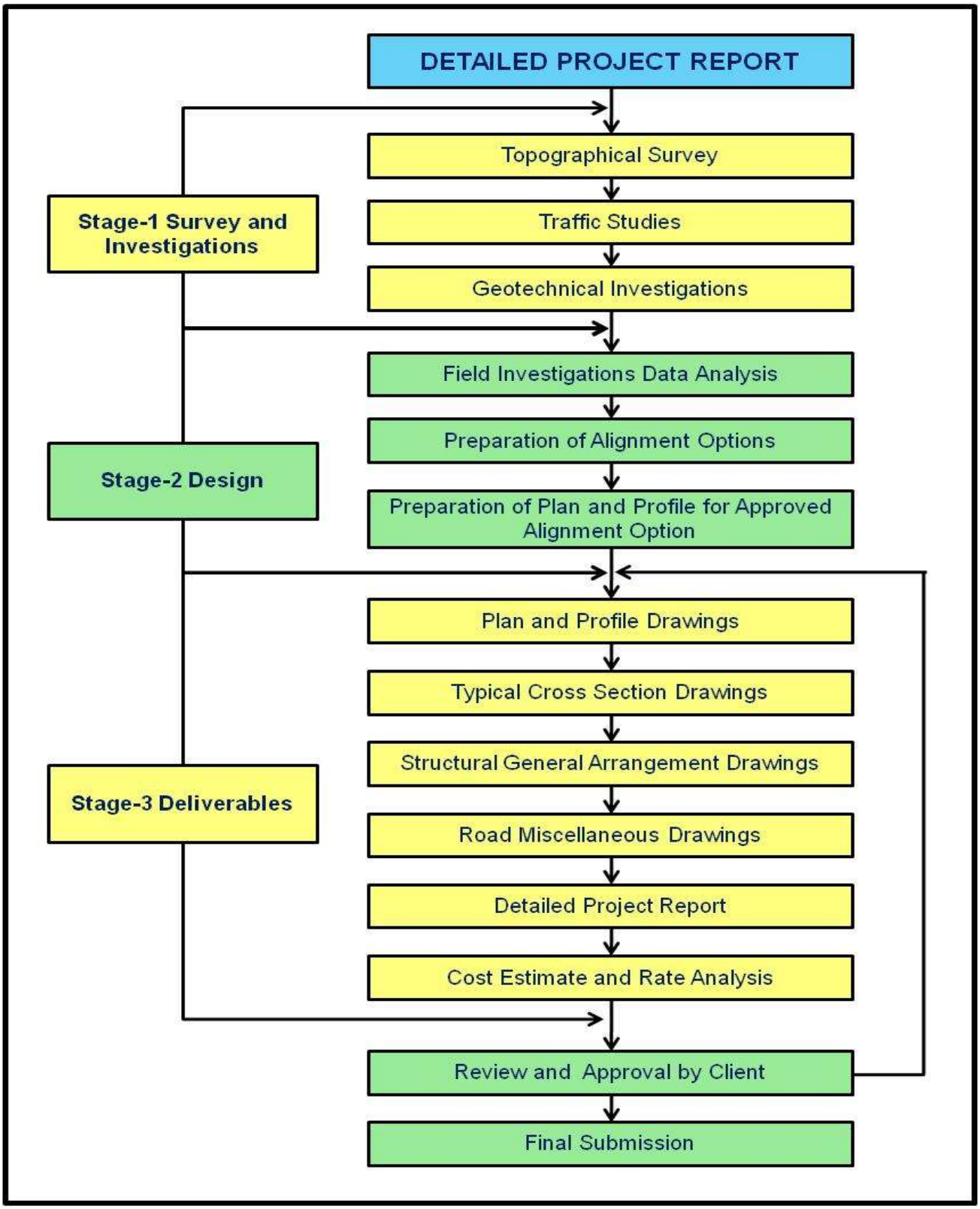


Figure 2-5 Line diagram showing the Methodology of study

1.13 Deliverables

As part of a detailed project report, the following are proposed to be submitted according to TOR's reporting.

VOLUME -I: Main Report

I. Detailed Project Report

1. Key Features and Summary of the Project Report

2. Introduction

3. Surveys and Investigations

4. Improvement Proposals and Design Standards

5. Design Report

6. Design Drawings

7. Project Cost

II. Detailed Estimate

III. Tender Documents

IV. Technical Specifications

VOLUME -II: Drawings

2 Survey and Investigation

2.1 General

Various engineering surveys have been carried out for the proper planning and design of the Elevated Corridor at the proposed site. Following surveys have been carried out:

• Topographical survey

• Traffic Survey

• Geotechnical investigations for foundations

The consultants visited the site along with BSMILE authority accompanied by concerned Executive engineer and with his team to acquaint the site and to study the various site related constraints which should be kept in mind while preparing the various alternative solutions for improvement of junction.

2.2 Reconnaissance Survey

A Reconnaissance Survey is carried out which is an initial, broad assessment of a study area to gather preliminary information and identify potential areas of interest. It's a crucial first step in many fields, including engineering, geology, and environmental science, helping to determine feasibility and guide further investigation.

The detailed ground reconnaissance and the primary task of the reconnaissance survey carried out are includes:

- Topographical features of the area.
- Physical features in the proposed road within and outside PROW.
- Preliminary identification of traffic pattern.
- Soil (textural classifications).
- Type and extent of existing utility services along the alignment (within PROW).
- Geology of study area.
- Seismic Zone.
- Collection of Storm Water Drain details along the project alignment.
- Collection of Topo map of project alignment from Survey of India.
- Collection of GTS Bench Mark details in project alignment.
- Collection of rainfall and flood data.
- Sources of construction material.
- Site Photos.

The data collected from the reconnaissance surveys were utilized for planning and programming the detailed surveys and investigations. All field studies, including the traffic surveys, were undertaken on the basis of information derived from reconnaissance survey. Details were taken at every 50m intervals along the existing road and proposed alignment and levels are established in the study area. Sufficient site photos were captured during site visit and annexed in this report

2.2.1 Data collection for Topographical survey

Before starting the survey work, the required primary data was collected in the relevant departments, based on which the topographic survey was continued. The following survey data was collected: An image of topo sheet showing the proposed project road is shown in Figure 2-1below.

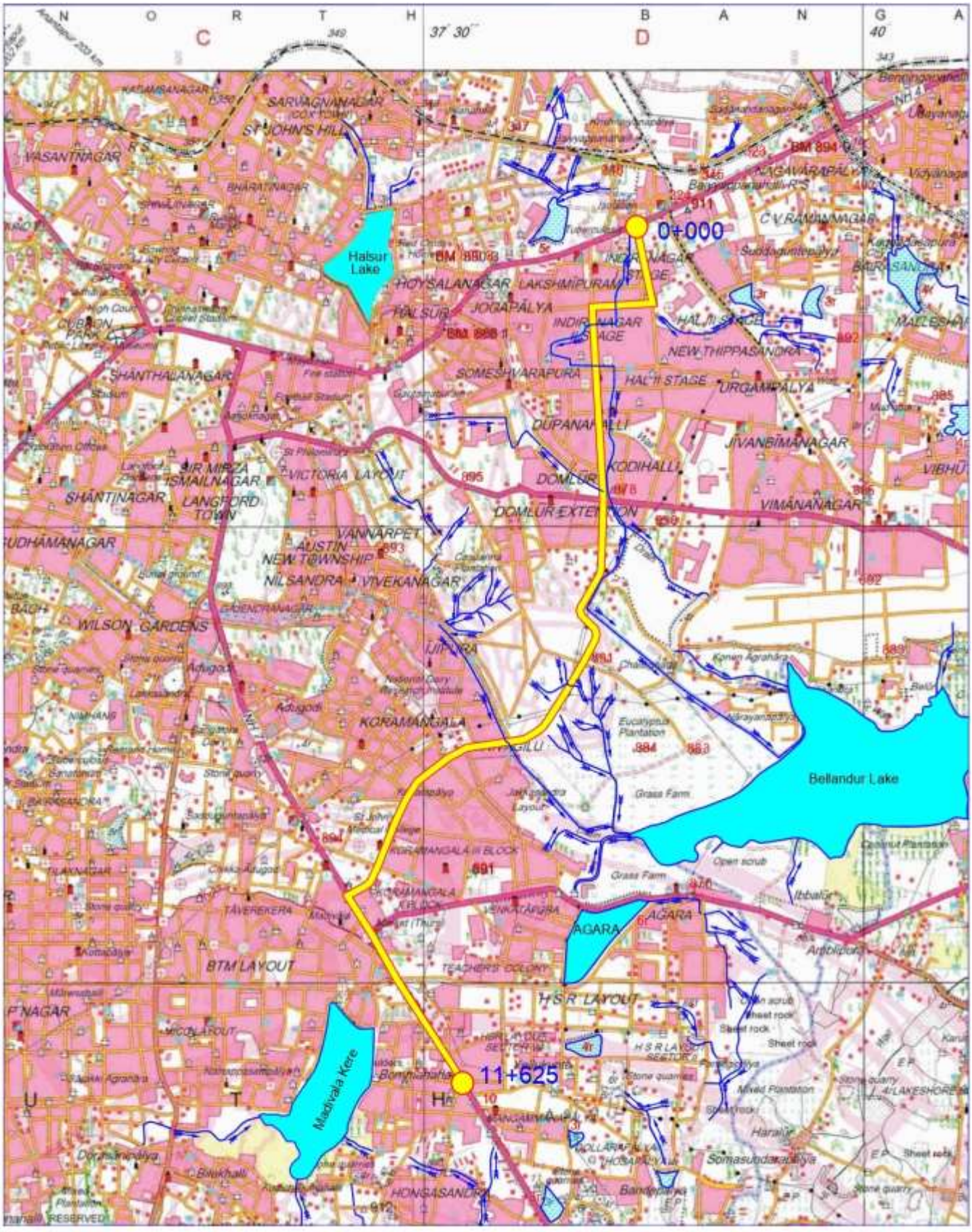


Figure 2-1 Survey of India new topo sheet No. D43X9 and Old No. 57 H/9 of the Project Road

The survey topo sheet relevant to the project road is collected from the Survey of India office. Proposed Project road is identified and marked in the survey of India new topo sheet No. D43X9 and Old No. 57 H/9. The purpose of marking the proposed alignment on topo sheet is to get an idea of general topo features in and around the project road and to assess the catchment area for planning drainage network along the project road.

2.2.2GTS Bench marks

The GTS bench marks stands for Great Trigonometrical Survey. These benchmarks are permanently fixed reference points with known elevations, established by the Survey of India, and are used as a standard for surveying and mapping. They serve as crucial reference points for determining elevations and depths in various surveying projects, especially when establishing mean sea level as a datum.

GTS Bench marks of Survey of India for obtaining Mean Sea Level (MSL)was identified in the project corridor and Digital Auto level was used all along the project corridor for establishing Bench Marks marked on the available permanent structure along the project corridor. The accuracy obtained in levelling survey is 12mm √k where k is distance in km. All levels used in this project are based on Survey of India GTS Bench Mark. These Bench Marks are marked in the topographical survey drawing. A list of Bench Mark is prepared and shown Table 2-1below.

Sl. No.	GTS BM No.	Description of Bench Mark	MSL	Topo Sheet No
1	DT BOM K-21/6	Engraved on marble Stone on South end of 1st Step of Guard Room of gte No. 2 in Survey of India Campus about 25m North of Union Bank of India 20m West of Ground Water Tank 0.14m above the ground level Bengaluru,Karnataka,India Sarjapur Marathahalli Road, Koramangala, Bengaluru, Karnataka 560034, India Lat 12.926188, Long 77.623878	896.950	New No. D43X9 And Old No. 57 H/9

2	BOM U3/35	BOM engraved on plinth of first step of foot path in front of HAL Main Gate it is about 35m North East of Mirage Sports Complex (HAL) gate. It is about 5m South of small water storage tank near gate. It is about 0.40m above ground level	897.748	

Table 2-1 Survey of India GTS Bench Mark details

2.3 Topographical Survey

The basic objective of the topographic survey was to collect the essential ground features of the proposed junction using Total Station to develop a Digital Terrain Model (DTM), to take care of design requirements of grade separated facility, identifying areas of restriction and their remedies. The data collected will result in the final design and is also used for the Computation of earthwork and other quantities required. The Picture showing the survey work carried out at site is shown in the Figure 2-2below.

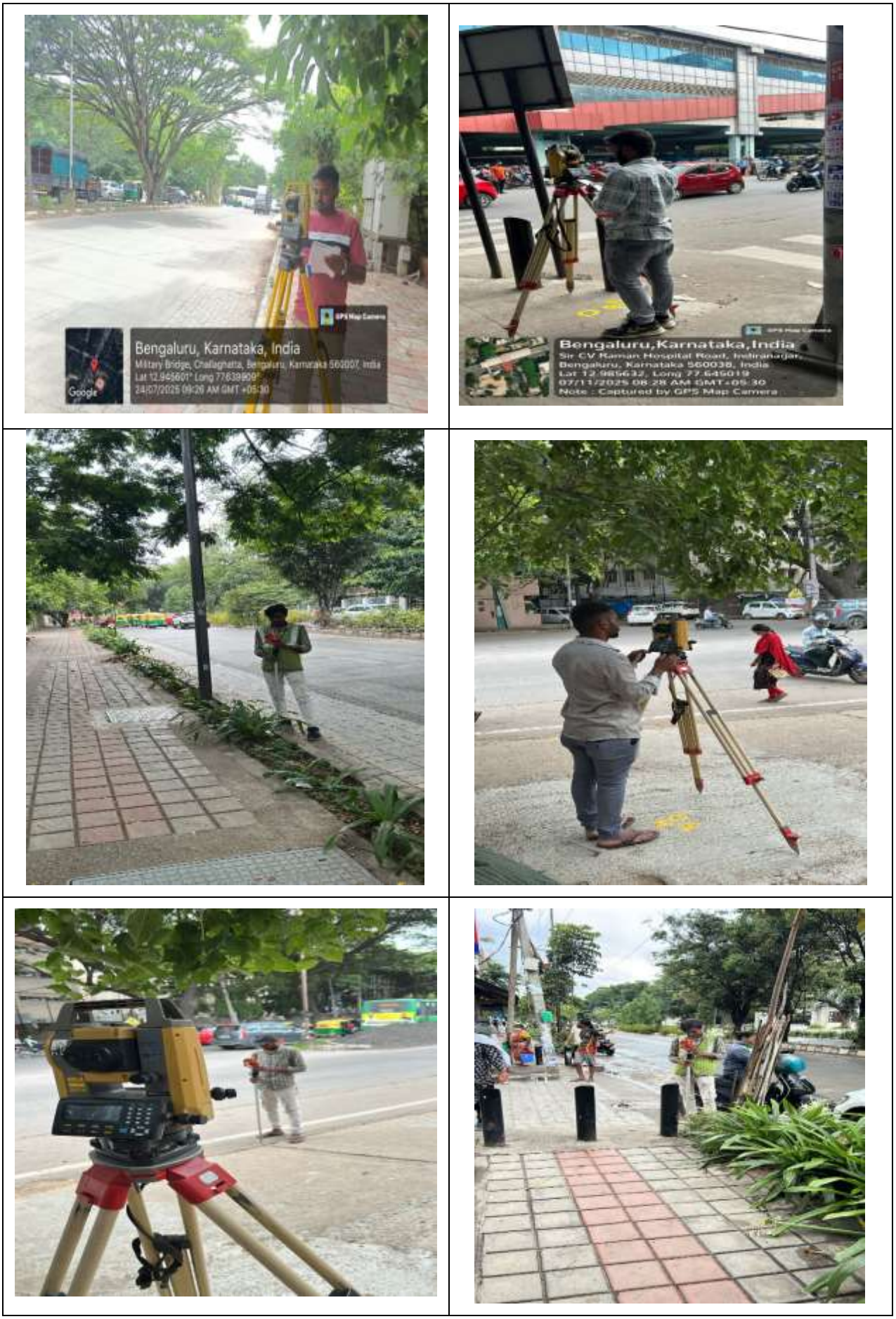

Bengaluru, Karnataka, India
Military Bridge, Challaghatta, Bengaluru, Karnataka 562007, India
Lat 12.945601° Long 77.639809°
24/07/2025 09:20 AM GMT +05:30
Google
Bengaluru,Karnataka,India
Sir CV Raman Hospital Road, Indiranagar,
Bengaluru, Karnataka 560038, India
Lat 12.985632, Long 77.645019
07/11/2025 08:28 AM GMT+05:30
Note : Captured by GPS Map Camera

Figure 2-2Topographical Survey at Project Road

2.3.1 Detailed Survey of Topographical Features

Topographical survey was conducted to capture the site features using 1 second accuracy total station instrument, Digital Auto level equipment and DGPS. The following features were collected during topographical survey to prepare the map of the physical features of the area.

Following existing features have been captured during the survey:

- Building lines, type of buildings (shops or houses, number of stories), trees and Right of Way boundary if available at site by presence of boundary stones.
- Road edges, centerline, shoulders/footpaths, median etc.
- Identifying all religious places, its locations, boundary lines and clear dimensions of compound walls and entrances.
- All service lines both above and below ground such as OFC cables, water and sewer pipes, gas pipes, electrical poles and cables, telephone poles and lines etc.
- Location of traffic islands, median, rotaries, dividers etc.
- Location of road side drains, clearly identifying the type (open/close), width of drain, including the beginning and end of drains.
- Positions of transformers, mast, towers etc.
- Apart from the above, the names of intersecting roads and other landmarks are also recorded and incorporated in the drawing.

Topographic survey was carried out using Total Station of 5-sec accuracy for detailed mapping and with higher accuracy total station during the traversing (min 3 sec). As part of the survey, the following activities were carried out.

Bench Marks: As first step of the survey, The GTS Bench mark locations were identified in the project corridor. Bench marks were marked at every 250m interval on available permanent structure along the project Road. The list of the Bench marks of the project corridor is described in this DPR in Page No. 38 & 39.

Cross – Sections: Cross sections along the road have been taken at every 10m interval in longitudinal direction for a minimum width of 15m or up to the building lines from the centerline of the existing carriageway on either side of the road. Cross section levels were taken at.

• Centerline of existing carriageway and median edges.

• Points between centerline and edge of carriageway.

• Shoulder/Footpath edges/carriageway edges.

• Additional points at locations of change in ground/critical points.

Longitudinal Section: Longitudinal section levels along the centerline were taken at every 25 m interval. Where curves or important features were encountered, this interval was suitably reduced. Cross sections points for the required width was taken corresponding to each point in the longitudinal section.

Map Plotting: The existing features surveyed were directly imported into Computer Aided Software and the details of the same has been plotted and presented for ready reference.

2.3.2 List of Temporary Bench Mark

The temporary Bench Mark as established at site, is listed in the Table 2-2 below with Coordinates and Elevations.

Sl. No.	Easting	Northing	Elevation	Point Id
1	786934.846	1437034.922	906.003	TBM-1
2	786958.300	1437044.730	906.667	TBM-2
3	787068.647	1437090.277	907.280	TBM-3
4	786955.148	1436943.634	905.983	TBM-4
5	786982.042	1436815.783	904.451	TBM-5
6	787001.507	1436725.322	901.899	TBM-6
7	787021.464	1436643.466	899.773	TBM-7
8	787057.746	1436491.824	900.961	TBM-8
9	787092.118	1436345.222	902.061	TBM-9
10	787118.284	1436244.724	901.959	TBM10
11	787121.688	1436052.381	898.183	TBM11
12	786856.087	1436239.838	899.243	TBM/10
13	786726.184	1436234.054	899.958	TBM/11
14	786578.588	1436221.479	899.907	TBM/12
15	786503.582	1436246.145	899.252	TBM/13
16	786517.943	1435991.034	902.809	TBM/14
17	786534.203	1435796.689	900.105	TBM/15
18	786522.920	1435572.512	896.091	TBM/16
19	786528.250	1435432.466	894.655	TBM/17
20	786534.769	1435316.455	893.369	TBM/18
21	786549.002	1435142.797	890.118	TBM/19
22	786577.616	1435036.049	887.833	TBM/20
23	786571.864	1434777.551	882.138	TBM/21
24	786562.113	1434004.047	879.321	TBM/22
25	786565.971	1433902.304	879.475	TBM/23
26	786597.430	1433721.994	879.690	TBM/24
27	786590.028	1433602.711	879.634	TBM/25

Sl. No.	Easting	Northing	Elevation	Point Id
28	786489.444	1433375.412	881.023	TBM/26
29	786338.663	1433146.866	886.051	TBM/27
30	786365.755	1433018.673	888.371	TBM/28
31	786540.122	1432880.321	890.698	TBM/29
32	786465.567	1432649.840	891.901	TBM/30
33	786336.203	1432431.412	887.226	TBM/31
34	786197.287	1432193.247	888.673	TBM/32
35	785993.439	1431888.882	885.555	TBM/33
36	784416.271	1430556.435	896.243	TBM-1
37	784296.631	1430338.319	893.352	TBM-2
38	784189.706	1430379.111	891.700	TBM-3
39	784133.275	1430261.609	889.064	TBM3
40	783999.296	1430421.996	891.334	TBM-4
41	784139.983	1430165.086	886.992	TBM-4
42	784223.487	1430055.363	885.185	TBM-5
43	784282.249	1429964.739	884.446	TBM-6
44	784354.469	1429777.060	882.181	TBM-7
45	784443.590	1429655.937	882.128	TBM-8
46	784488.065	1429543.083	880.654	TBM-9
47	784549.045	1429469.461	880.562	TBM10
48	784770.305	1429188.923	881.126	TBM11
49	786713.859	1434264.691	886.044	TS-P1
50	786681.977	1434261.809	884.458	TS-P2
51	786697.649	1434246.305	881.526	TS-P3
52	786676.886	1434352.580	886.392	TS-P4
53	786762.176	1434266.252	888.695	TS-P5
54	786935.891	1437037.697	906.102	TS-R1
55	786948.460	1436989.952	906.080	TS-R2
56	786899.893	1437023.552	905.458	TS-R3
57	787011.190	1437069.988	906.458	TS-R4
58	786961.069	1436930.386	905.871	TS-R5
59	786986.182	1436811.835	903.912	TS-R6
60	787004.703	1436729.252	901.899	TS-R7
61	787023.418	1436642.354	899.734	TS-R8
62	787043.442	1436558.439	899.566	TS-R9
63	787054.515	1436497.425	900.646	TS-R10
64	787074.807	1436412.488	901.815	TS-R11
65	787093.791	1436328.115	902.003	TS-R12
66	787105.717	1436268.699	901.641	TS-R13
67	787010.697	1436246.169	900.518	TS-R14
68	786846.232	1436236.853	899.007	TS-R15
69	786718.342	1436232.220	899.700	TS-R16
70	786577.959	1436224.719	899.773	TS-R17

Sl. No.	Easting	Northing	Elevation	Point Id
71	786505.262	1436250.224	898.547	TS-R18
72	786482.967	1436188.050	899.965	TS-R19
73	786488.897	1436066.769	902.566	TS-R20
74	786519.355	1435998.690	902.855	TS-R21
75	786522.423	1435935.312	902.177	TS-R22
76	786532.051	1435798.368	900.067	TS-R23
77	786535.032	1435741.561	899.032	TS-R24
78	786540.710	1435668.826	897.865	TS-R25
79	786521.424	1435560.476	895.871	TS-R26
80	786527.234	1435446.722	894.481	TS-R27
81	786538.066	1435319.617	893.150	TS-R28
82	786539.668	1435243.385	892.039	TS-R29
83	786545.756	1435139.140	889.810	TS-R30
84	786581.203	1435035.997	887.564	TS-R31
85	786566.946	1434878.543	884.102	TS-R32
86	786567.974	1434778.032	881.768	TS-R33
87	786605.164	1434600.029	883.666	TS-R34
88	786584.677	1434587.478	886.873	TS-R35
89	786617.472	1434297.796	888.724	TS-R36
90	786607.133	1434258.733	889.488	TS-R37
91	786561.939	1433956.888	879.372	TS-R38
92	786563.089	1433926.498	879.280	TS-R39
93	786565.844	1433897.592	879.108	TS-R40
94	786569.405	1433798.979	878.789	TS-R41
95	786594.843	1433738.720	878.729	TS-R42
96	786588.559	1433622.654	878.853	TS-R43
97	786589.187	1433601.496	878.924	TS-R44
98	786490.192	1433379.908	880.982	TS-R45
99	786433.261	1433330.571	881.355	TS-R46
100	786337.057	1433141.608	886.162	TS-R47
101	786362.359	1433029.263	887.895	TS-R48
102	786538.516	1432882.716	890.595	TS-R49
103	786533.738	1432772.512	891.114	TS-R50
104	786461.424	1432646.147	891.339	TS-R51
105	786434.794	1432601.217	891.050	TS-R52
106	786336.642	1432432.935	887.171	TS-R53
107	786282.282	1432341.124	887.344	TS-R54
108	786200.523	1432201.096	888.364	TS-R55
109	786122.967	1432069.017	887.673	TS-R56
110	785992.122	1431887.796	885.551	TS-R57
111	785843.812	1431811.889	885.191	TS-R58
112	785783.767	1431801.199	885.038	TS-R59
113	784398.041	1430561.844	896.062	TS-S1

Sl. No.	Easting	Northing	Elevation	Point Id
114	784372.201	1430575.840	896.086	TS-S2
115	784324.849	1430382.585	893.524	TS-S3
116	784296.192	1430340.792	893.089	TS-S4
117	784276.141	1430327.772	892.155	TS-S5
118	784241.191	1430309.826	891.078	TS-S6
119	784278.452	1430372.225	892.787	TS-S6
120	784128.158	1430283.563	888.964	TS-S7
121	784194.979	1430389.344	891.927	TS-S7
122	784134.649	1430398.110	891.475	TS-S8
123	784109.070	1430243.972	888.150	TS-S8
124	784068.581	1430411.846	891.184	TS-S9
125	784137.608	1430192.478	887.120	TS-S9
126	784191.712	1430105.513	885.746	TS-S10
127	784022.336	1430421.527	891.216	TS-S10
128	783996.149	1430423.821	891.252	TS-S11
129	784218.958	1430059.116	885.081	TS-S11
130	784278.047	1429970.353	884.019	TS-S12
131	784320.130	1429896.834	883.098	TS-S13
132	784345.001	1429792.911	882.418	TS-S14
133	784361.881	1429763.603	882.203	TS-S15
134	784433.975	1429716.586	881.859	TS-S16
135	784373.507	1429746.865	881.944	TS-S17
136	784412.656	1429683.647	881.841	TS-S18
137	784504.097	1429543.321	881.388	TS-S19
138	784568.185	1429469.079	880.809	TS-S20
139	784576.405	1429532.708	880.858	TS-V1
140	784624.382	1429483.196	880.363	TS-V2
141	784757.647	1429211.617	881.805	TS-V3
142	784719.030	1429283.056	880.653	TS-V4

Table 2-2 List of Temporary Bench mark with Coordinates

2.4 Traffic Survey

Primary traffic surveys which involve classified volume counts at selected sections along the project corridor to carrying out classified vehicle counts, with appropriate vehicle classification was adopted as per relevant guidelines of IRC keeping in mind the presence of different vehicle categories operating on the project road. The equivalent Passenger Car Unit (PCU) values was used as per relevant IRC guidelines.

The traffic volume count surveys were conducted on 25th April 2025 as per IRC: 106-1990 guild lines, for Fourteen hours from morning 6 am to evening 8 pm to obtain classified count at the Project road. The data was collected on working day by deploying enumerators to record data for each hour within

fifteen minutes intervals to obtain data on the magnitude of traffic flow, hourly variation and the traffic composition. Analysis of survey data are discussed in the chapter 5 Design Report.

2.5 Geo Technical Investigations

Introduction

Geotechnical investigation for the proposed project from Old Madras road to Silk Board via Indira Nagara 100 Feet Road, Domlur and Ejipura. The total length of the corridor is 11.625 km. The primary objective of this investigation is to establish the geotechnical condition at the site and to evaluate the allowable bearing pressure and other engineering design parameters through the various field and laboratory tests. The report consists of the details on the field and laboratory tests and the recommendations made based on the test results.

Field work comprising of drilling of boreholes conducting SPT tests, collection of samples. The primary objective of this investigation was to obtain information about the sub-surface conditions at the site and obtain net allowable bearing pressure for design of foundations. The location of boreholes for the proposed construction site are marked in the topographical survey map annexed in this report. The Details are summarized below:

Sl. No.	BH No.	Chainage in m	MSL	Depth of explorations (m)	Water Table, m
1	BH-01	20.00	906.038	23.50	Nil
2	BH-02	1330.00	899.604	30	Nil
3	BH-03	2200.00	894.705	30	Nil
4	BH-04	3200.00	881.215	30	Nil
5	BH-05	4400.00	881.326	30	Nil
6	BH-06	6400.00	884.307	21	Nil
7	BH-07	7200.00	881.078	30	Nil
8	BH-08	8400.00	895.278	30	Nil
9	BH-09	8775.00	888.938	30	Nil
10	BH-10	9640.00	881.302	23	Nil

Boring and Drilling

The field investigation comprised of advancing 150mm boreholes using rotary drilling rig with bentonite mud circulation. Standard penetration test (SPT) was conducted at every 1.50m intervals as per IS: 2131. The number of blows for 30cm penetration of split spoon sampler was recorded as N-values. The boreholes were terminated after drilling to their respective depth. The various sub-surface strata are presented in the respective bore charts.

Standard Penetration Test (SPT) in boreholes

Standard Penetration Test (SPT) to determine penetration resistance was conducted in the boreholes using the procedure described in IS: 2131. In this method, driving bit is replaced by split spoon sampler (50.8 mm OD and 35 mm ID) and the sampler is driven by dropping 63.5 kg hammer on the top of the driving collar with a free fall of 75 cm. The length of the sampler is 60 cm. The sampler is first driven through 15 cm as "Seating Drive". It is further driven through 30 cm. The number of blows required to drive the sampler for 30 cm beyond seating drive is termed as "Penetration Resistance, N". Representative samples were collected using split spoon sampler. Where full 30cm penetration beyond seating drive was not possible, number of blows and corresponding penetration is mentioned in bore log sheets.

Sample collections

Samples were collected from split spoon sampler used for conducting SPT at close intervals of 1.5m up to end of respective strata. Rock formations are usually drilled by tungsten carbide core bits, core samples were retained and collected. Very dense strata being encountered at shallow depths, UDS Sampling as per IS: 2132 was limited in upper depths. Samples were collected from split spoon sampler used in SPT done at 2.0m intervals as per IS:2131. Undisturbed sampling was limited since very dense strata is noticed from shallow depths itself in most of the boreholes with N Values generally >30).

Rock formations

In boreholes where rock cores could be recovered, same was logged, placed sequentially in good quality wooden core boxes. Individual core piece lengths were measured and core recovery and Rock quality designation computed as below.

Rock core recovery {CR % = (Length of Core / Length of run) x 100} Rock quality designation (RQD) = (Total length of core pieces of >100mm / length of run) x 100}. Same is reflected in bore logs.

Water Table

During the time of investigations, subsequent to completion of borehole and after allowing water level to stabilize for minimum 24 hours, water table was not encountered in the explored depth below natural ground level during the time of investigation. However, water levels are invariably subjected to seasonal fluctuations.

Laboratory Tests

The following Tests were carried out

• Grain size analysis

• Natural Moisture content

• Atterberg's Limits

Sub - Soil profile analysis

Nature of Soil Stratification Based on detailed analysis, the soil conditions is described for the entire project corridor as under

Layer I: Soil Overburden

The sub-soil stratification essentially comprises of sandy Silt/silty Sand with clay binder formations with layer thickness of 9.50 – 19.00m.

Layer II: Completely Weathered Rock

Below layer I and comprises of 'very dense' complete to highly weathered rock (SPT 'N' values consistently N >100 and Nil core recovery). In 'in-situ' conditions, stratum is considered 'very dense/stiff' /incompressible with very good bearing characteristics. In this layer sample recovery was limited and sufficient for visual classification.

Layer III- Rock Formations

Rock is observed in all the bore holes. Based on the core recovery and Rock Quality Designation rock may classified as Hard rock formations given below.

Sl. No.	BH No.	Explored Depth, m	Thickness of layer in sequence (m)		
			Layer – I Soil	Layer – II CWR(N>100)	Layer III- MWR/HR
1	BH-01	23.50	0.00 to 18.00	18.00 to 23.50	-
2	BH-02	30.00	0.00 to 19.50	19.50 to 30.00	-
3	BH-03	30.00	0.00 to 21.00	21.00 to 30.00	-
4	BH-04	30.00	0.00 to 13.50	13.50 to 30.00	-
5	BH-05	30.00	0.00 to 18.00	18.00 to 30.00	-
6	BH-06	21.00	0.00 to 12.00	12.00 to 21.00	-
7	BH-07	30.00	0.00 to 16.50	16.50 to 30.00	-
8	BH-08	30.00	0.00 to 22.50	22.50 to 30.00	-
9	BH-09	30.00	0.00 to 21.00	22.50 to 30.00	-
10	BH-10	23.00	0.00 to 12.00	12.00 to 23.00	-

EGL - Existing Ground Level,

ROL - Rock Occurrence Level,

SR - Soft Rock,

CWR - Completely Weathered Rock.

Recommendations

Based on the geotechnical investigations carried out for the proposed project, following recommendations are made:

For shallow foundations

1. Foundations for all the structures shall be taken minimum 1.5m below structural floor level.
2. Isolated/combined footing up to minimum width 2m may be designed with the following allowable bearing pressure of, which gives a factor of safety of 3.0 against shear failure and for an allowable settlement of 25mm.

Sl. No.	Location	Foundation depth below EGL(m)	Net SBC, (kN/m2)
1	BH-01	2.00/3.00	200/250
2	BH-02	2.00/3.00	200/250
3	BH-03	2.00/3.00	200/250
4	BH-04	2.00/3.00	200/250
5	BH-05	2.00/3.00	200/250
6	BH-06	2.00/3.00	200/250
7	BH-07	2.00/3.00	200/250
8	BH-08	2.00/3.00	200/250
9	BH-09	2.00/3.00	200/250
10	BH-10	2.00/3.00	200/250

Note:

1. During excavations, in case any variations in strata/seepage are noticed, the same shall be brought to the notice of geotechnical engineer for review of net SBC recommended.
2. The bottom of foundation shall be properly levelled and verified for loose pockets/weaker zones and if found, the same shall be replaced with lean concrete.

Recommendations for deep foundations

It is recommended for RCC bored cast in-situ piles wherever deep foundations are envisaged.

Inferences from borehole investigations

Heavy load transfer inspected from the Bridge structure proposed. So deep foundations such as Bored Cast-in-situ Piles is recommended. Pile diameter has been considered as 1.2m. Piles should be socketed three times the Pile diameter in dense weathered rock/refusal strata (N>100) layer or 0.5 times the pile diameter in to Rock formations whichever is met earlier.

Recommendations for Deep Foundations

For deep foundations RCC bored cast in-situ piles is recommended. Design calculations are as per IRC 78 approach Appendix V Method 2.

Sl. No.	BH No.	Depth of Pile, m	Pile dia, D (m)	Safe axial load (tons)	Lateral load (tons) (fixed head condition)
1	BH-01	21.00	1.20	580	75
2	BH-02	22.50	1.20	580	75
3	BH-03	24.00	1.20	580	75
4	BH-04	18.00	1.20	580	75
5	BH-05	24.00	1.20	580	75
6	BH-06	16.00	1.20	580	75
7	BH-07	23.00	1.20	580	75
8	BH-08	25.00	1.20	580	75
9	BH-09	24.00	1.20	580	75
10	BH-10	17.00	1.20	580	75

However actual load carrying capacity of pile may be arrived by conducting initial pile load test.

Note:

- Concreted pile lengths are estimated based on Borehole data. Actual Length of piles may vary. During actual execution, pile termination shall be decided based on chiseling / PPR deduced by SPT 'N' value or any approved criteria. Broad description of PPR criteria related to SPT N is given below
- Pile Termination reconfirmation-For reconfirming the strata at pile termination level (socket strata) Chiseling criteria or Pile Penetration Ratio recommended in IRC-78 may be used

Pile Penetration ratio (PPR) reflects the energy in ton-m required to advance pile bore of 1m2 cross sectional area by 1cm or 10mm. SPT Tests are used to assess this and minimum N Value /blow count of 100 may be used as a guideline.

From SPT Test for N=100 (Indicative calculation)

Energy E Spent for N blows =63.5kgx 75cm x N Blows

Area of SPT Sampler = $\pi D2/4 = 0.785x\ 25.81 = 20.26cm^2$

D =5.08 cm Outer diameter (Standard samplers)

For N=100, Energy E = 63.5 x 75x100x 10-5 t-m

Conclusion

The scope of the geotechnical investigation was limited to evaluating the nature and type of sub-soil strata, determining foundation design parameters, and identifying the type and depth of sub-structure foundations at the project site. The recommendations provided are based on the limited field and laboratory tests carried out during this stage.

During actual excavation for construction, further recommendations and appropriate modifications may be required. Any discrepancies observed between site conditions and this report should be immediately brought to the notice of the project consultant, who will provide suitable guidance.

It must be emphasized that this report is intended solely for the preparation of the Detailed Project Report (DPR) and tender processing purposes. A comprehensive soil investigation shall be undertaken by the contractor at the execution stage, in accordance with the final design requirements

BORE LOG SHEET

Project:	**Construction of Proposed Elevated Corridor from Old Madras Road from Swami Vivekananda Metro Station to Silk Board Junction on Hosur Road via Indiranagar-Domlur-Madiwala**										
Client:	**Bengaluru Smart Infrastructure Limited (B Smile), # 108, 1st Floor, Annexe-2 Building, N.R. Square, Bengaluru - 560002.**										
BH No:	**1**		**Ground Water Level : Not Encountered**				**Termination Depth:**			**23.5m**	
Location	**Marked in Topographigal Survey Drawing**						**Page No. 1**			**MSL : 906.038**	
Description of Sub-soil stratum	**Depth (m)**	**Legend**	**Sample**	**SPT TEST, Number of blows recorded**			**N value=N2+N3**	**Core Recovery, %**	**RQD %**	**Remarks**
				1st 15cm	**2nd 15cm**	**3rd 15cm**				
				N1	**N2**	**N3**				
Brownish silty Sand with gravel	0.0									
	0.5		DS							
	1.5		SPT DS	3	4	6	10			
Grayish brown silty sand	3.0		SPT DS	50B/14cm	R		>100			
	4.5		SPT DS	25	30	34	64			
	6.0		SPT DS	30	35	38	73			
Grayish to whitish yellow silty Sand	7.5		SPT DS	10	13	15	28			
	9.0		SPT DS	15	16	18	34			
Grayish yellow CWR	10.5		SPT DS	35	50B/0cm	R	>100			
Grayish white CWR	12.0		SPT DS	48	50B/5cm	R	>100			
Grayish yellow CWR	13.5		SPT DS	25	32	36	68			
	15.0		SPT DS	30	34	38	72			
	16.5		SPT DS	31	37	40	77			
Grayish brown CWR	18.0		SPT DS	50B/0cm	R		>100			
	19.5		SPT DS	50B/0cm	R		>100			
	21.0		SPT DS	50B/10cm	R		>100			
	22.0									
Blackish white SR	22.5		CR					34	Nil	
Blackish white HR	23.5		CR					95	95	

Note :
Bore hole was terminated at 23.5m depth below existing ground level
SPT - Standard penetration test Refusal means SPT N>50 R= Rebound HR:Hard Rock
DS - Undisturbed sample B=No. of blows SR: Soft Rock
MWR:Moderatly Weathered Rock CWR: completely weathered rock

BORE LOG SHEET

Project:	**Construction of Proposed Elevated Corridor from Old Madras Road from Swami Vivekananda Metro Station to Silk Board Junction on Hosur Road via Indiranagar-Domlur-Madiwala**									
Client:	**Bengaluru Smart Infrastructure Limited (B Smile), # 108, 1st Floor, Annexe-2 Building, N.R. Square, Bengaluru - 560002.**									
BH No:	**2**		**Ground Water Level : Not Encountered**				**Termination Depth:**			**30.0m**
Location	**Marked in Topographigal Survey Drawing**						**Page No. 1**			**MSL : 899.604**
Description of Sub-soil stratum	**Depth (m)**	**Legend**	**Sample**	**SPT TEST, Number of blows recorded**			**N value=N2+N3**	**Core Recovery, %**	**RQD %**	**Remarks**
				1st 15cm	**2nd 15cm**	**3rd 15cm**				
				N1	**N2**	**N3**				
Filled up	0.0									
	0.5		DS							
Brownish to yellowish white sandy Silt	1.5		SPT DS	4	7	10	17			
	3.0		SPT DS	6	10	15	25			
Whitish to pinkish yellow sandy Silt	4.5		SPT DS	7	8	13	21			
	6.0		SPT DS	9	10	16	26			
	7.5		SPT DS	9	12	16	28			
	9.0		SPT DS	11	14	20	34			
	10.5		SPT DS	10	16	23	39			
	12.0		SPT DS	9	20	27	47			
	13.5		SPT DS	11	18	28	46			
Yellowish to grayish white CWR	15.0		SPT DS	18	24	31	55			Refusal Strata
	16.5		SPT DS	18	24	36	60			
Whitish pink CWR	18.0		SPT DS	25	27	38	65			
	19.5		SPT DS	50B/12cm	R		>100			
	21.0		SPT DS	50B/10cm	R		>100			
Yellowish to whitish brown SDR	22.5		SPT DS	50B/1cm	R		>100			
	24.0		SPT DS	50B/1cm	R		>100			
	25.5		SPT DS	50B/1cm	R		>100			
	27.0		SPT DS	50B/1cm	R		>100			
	28.5		SPT DS	50B/1cm	R		>100			
	30.0		SPT DS	50B/1cm	R		>100			

Note :
Bore hole was terminated at 30.0m depth below existing ground level

SPT - Standard penetration test Refusal means SPT N>50 R= Rebound HR:Hard Rock
DS - Undisturbed sample B=No. of blows SR: Soft Rock
MWR:Moderatly Weathered Rock CWR: completely weathered rock

BORE LOG SHEET

Project:	**Construction of Proposed Elevated Corridor from Old Madras Road from Swami Vivekananda Metro Station to Silk Board Junction on Hosur Road via Indiranagar-Domlur-Madiwala**								
Client:	**Bengaluru Smart Infrastructure Limited (B Smile), # 108, 1st Floor, Annexe-2 Building, N.R. Square, Bengaluru - 560002.**								
BH No:	**3**		**Ground Water Level : Not Encountered**				**Termination Depth:**		**30.0m**
Location	**Marked in Topographigal Survey Drawing**						**Page No. 1**		**MSL : 894.705**

Description of Sub-soil stratum	Depth (m)	Legend	Sample	SPT TEST, Number of blows recorded			N value=N2+N3	Core Recovery, %	RQD %	Remarks
				1st 15cm	2nd 15cm	3rd 15cm				
				N1	N2	N3				
Brownish Silty Sand with Gravel	0.0									
	0.5		DS							
Yellowish brown silty Sand with gravel										
	1.5		SPT DS	5	7	9	16			
Whitish to yellowish brown sandy Silt	3.0		SPT DS	6	9	11	20			
	4.5		SPT DS	8	11	13	24			
	6.0		SPT DS	11	14	16	30			
Yellowish gray sandy Silt	7.5		SPT DS	14	16	19	35			
Whitish pink CWR	9.0		SPT DS	17	25	29	54			Refusal Strata
	10.5		SPT DS	19	26	32	58			
Yellowish pink CWR	12.0		SPT DS	18	26	35	61			
	13.5		SPT DS	20	26	40	66			
Whitish gray CWR	15.0		SPT DS	12	22	30	52			
	16.5		SPT DS	16	26	36	62			
Yellowish pink CWR	18.0		SPT DS	12	15	16	31			
	19.5		SPT DS	17	25	35	60			
Whitish to yellowish gray CWR	21.0		SPT DS	50B/7cm	R		>100			
	22.5		SPT DS	50B/6cm	R		>100			
Yellowish to whitish brown SDR	24.0		SPT DS	50B/4cm	R		>100			
	25.5		SPT DS	50B/5cm	R		>100			
	27.0		SPT DS	50B/7cm	R		>100			
	28.5		SPT DS	50B/5cm	R		>100			
	30.0		SPT DS	50B/4cm	R		>100			

Note :

Bore hole was terminated at 30.0m depth below existing ground level

SPT - Standard penetration test — Refusal means SPT N>50 — R= Rebound — HR:Hard Rock

DS - Undisturbed sample — B=No. of blows — SR: Soft Rock

MWR:Moderatly Weathered Rock — CWR: completely weathered rock

BORE LOG SHEET

Project:	**Construction of Proposed Elevated Corridor from Old Madras Road from Swami Vivekananda Metro Station to Silk Board Junction on Hosur Road via Indiranagar-Domlur-Madiwala**									
Client:	**Bengaluru Smart Infrastructure Limited (B Smile), # 108, 1st Floor, Annexe-2 Building, N.R. Square, Bengaluru - 560002.**									
BH No:	**4**		**Ground Water Level : Not Encountered**				**Termination Depth:**			**30.0m**
Location	**Marked in Topographigal Survey Drawing**						**Page No. 1**			**MSL : 881.215**
Description of Sub-soil stratum	**Depth (m)**	**Legend**	**Sample**	**SPT TEST, Number of blows recorded**			**N value=N2+N3**	**Core Recovery, %**	**RQD %**	**Remarks**
				1st 15cm	**2nd 15cm**	**3rd 15cm**				
				N1	**N2**	**N3**				
Filled up	0.0 0.5		DS							
Whitish yellow silty Sand	1.5		SPT DS	5	5	7	12			
	3.0		SPT DS	5	9	13	22			
Whitish to yellowish pink silty Sand	4.5		SPT DS	7	10	15	25			
Grayish yellow silty Sand	6.0		SPT DS	8	13	16	29			
	7.5		SPT DS	10	17	20	37			
Whitish to pinkish yellow silty Sand	9.0		SPT DS	12	19	25	44			
	10.5		SPT DS	9	9	12	21			
	12.0		SPT DS	10	13	16	29			
Whitish brown CWR	13.5		SPT DS	48	50B/16cm	R	>100			Refusal Strata
	15.0		SPT DS	50B/8cm	R		>100			
	16.5		SPT DS	50B/7cm	R		>100			
Yellowish to whitish brown SDR	18.0		SPT DS	50B/1cm	R		>100			
	19.5		SPT DS	50B/1cm	R		>100			
	21.0		SPT DS	50B/1cm	R		>100			
	22.5		SPT DS	50B/1cm	R		>100			
	24.0		SPT DS	50B/1cm	R		>100			
	25.5		SPT DS	50B/1cm	R		>100			
	27.0		SPT DS	50B/1cm	R		>100			
	28.5		SPT DS	50B/1cm	R		>100			
	30.0		SPT DS	50B/1cm	R		>100			

Note :

Bore hole was terminated at 30.0m depth below existing ground level

SPT - Standard penetration test Refusal means SPT N>50 R= Rebound HR:Hard Rock

DS - Undisturbed sample B=No. of blows SR: Soft Rock

MWR:Moderatly Weathered Rock CWR: completely weathered rock

BORE LOG SHEET

Project:	Construction of Proposed Elevated Corridor from Old Madras Road from Swami Vivekananda Metro Station to Silk Board Junction on Hosur Road via Indiranagar-Domlur-Madiwala
Client:	Bengaluru Smart Infrastructure Limited (B Smile), # 108, 1st Floor, Annexe-2 Building, N.R. Square, Bengaluru - 560002.

BH No:	5	**Ground Water Level : Not Encountered**	**Termination Depth:**		30.0m
Location	Marked in Topographigal Survey Drawing		Page No. 1		MSL : 881.326

Description of Sub-soil stratum	Depth (m)	Legend	Sample	SPT TEST, Number of blows recorded			N value=N2+N3	Core Recovery, %	RQD %	Remarks
				1st 15cm	2nd 15cm	3rd 15cm				
				N1	N2	N3				
Filled up	0.0									
	0.5		DS							
Yellowish pink sandy Silt	1.5		SPT DS	2	3	3	6			
Whitish to grayish yellow silty Sand	3.0		SPT DS	3	4	5	9			
	4.5		SPT DS	4	5	7	12			
	6.0		SPT DS	5	8	13	21			
	7.5		SPT DS	8	12	20	32			
Grayish to yellowish pink silty Sand	9.0		SPT DS	10	18	18	36			
	10.5		SPT DS	9	18	20	38			
Pinkish to grayish yellow silty Sand	12.0		SPT DS	11	20	25	45			
	13.5		SPT DS	9	15	21	36			
	15.0		SPT DS	11	19	24	43			
	16.5		SPT DS	9	17	20	37			
	18.0		SPT DS	23	50B/10cm	R	>100			Refusal Strata
	19.5		SPT DS	50B/5cm	R		>100			
Yellowish to whitish brown SDR	21.0		SPT DS	50B/2cm	R		>100			
	22.5		SPT DS	50B/1cm	R		>100			
	24.0		SPT DS	50B/1cm	R		>100			
	25.5		SPT DS	50B/1cm	R		>100			
	27.0		SPT DS	50B/1cm	R		>100			
	28.5		SPT DS	50B/1cm	R		>100			
	30.0		SPT DS	50B/1cm	R		>100			

Note :
Bore hole was terminated at 30.0m depth below existing ground level

SPT - Standard penetration test Refusal means SPT N>50 R= Rebound HR:Hard Rock

DS - Undisturbed sample B=No. of blows SR: Soft Rock

MWR:Moderatly Weathered Rock CWR: completely weathered rock

BORE LOG SHEET

Project:	**Construction of Proposed Elevated Corridor from Old Madras Road from Swami Vivekananda Metro Station to Silk Board Junction on Hosur Road via Indiranagar-Domlur-Madiwala**									
Client:	**Bengaluru Smart Infrastructure Limited (B Smile), # 108, 1st Floor, Annexe-2 Building, N.R. Square, Bengaluru - 560002.**									
BH No:	**6**		**Ground Water Level : Not Encountered**				**Termination Depth:**			**21.0m**
Location	**Marked in Topographical Survey Drawing**						**Page No. 1**			**MSL : 884.307**
Description of Sub-soil stratum	**Depth (m)**	**Legend**	**Sample**	**SPT TEST, Number of blows recorded**			**N value=N2+N3**	**Core Recovery, %**	**RQD %**	**Remarks**
				1st 15cm	**2nd 15cm**	**3rd 15cm**				
				N1	**N2**	**N3**				
Reddish Silty Sand	0.0									
	0.5		DS							
Reddish Yellow Silty Sand	1.5		SPT DS	3	5	8	13			
	3.0		SPT DS	6	8	11	19			
Brownish Yellow Sandy Silt	4.5		SPT DS	24	50B/5cm	R	>100			
	6.0		SPT DS	27	50B/6cm	R	>100			
Grayish to Whitish Yellow Silty Sand	7.5		SPT DS	29	50B/8cm	R	>100			
	9.0		SPT DS	83	50B/0cm	R	>100			
	10.5		SPT DS	50B/10cm	R		>100			
	12.0		SPT DS	50B/9cm	R		>100			
Grayish to Whitish Yellow CWR	13.5		SPT DS	50B/0cm	R		>100			
	15.0		SPT DS	50B/0cm	R		>100			
	16.0		SPT DS	50B/0cm	R		>100			
Grayish to Blackish White HR	18.0		SPT DS	50B/0cm	R		>100			
	19.5		SPT DS	50B/0cm	R		>100			
	21.0		SPT DS	CR				100	100	

Note :

Bore hole was terminated at 21.0m depth below existing ground level

SPT - Standard penetration test — Refusal means SPT N>50 — R= Rebound — HR:Hard Rock

DS - Undisturbed sample — B=No. of blows — SR: Soft Rock

MWR:Moderatly Weathered Rock — CWR: completely weathered rock

BORE LOG SHEET

Project:	**Construction of Proposed Elevated Corridor from Old Madras Road from Swami Vivekananda Metro Station to Silk Board Junction on Hosur Road via Indiranagar-Domlur-Madiwala**								
Client:	**Bengaluru Smart Infrastructure Limited (B Smile), # 108, 1st Floor, Annexe-2 Building, N.R. Square, Bengaluru - 560002.**								
BH No:	**7**		**Ground Water Level : Not Encountered**				**Termination Depth:**		**30.0m**
Location	**Marked in Topographical Survey Drawing**						**Page No. 1**		**MSL : 881.078**
Description of Sub-soil stratum	**Depth (m)**	**Legend**	**Sample**	**SPT TEST, Number of blows recorded**			**N value=N2+N3**	**Core Recovery, %**	**RQD %**	**Remarks**
				1st 15cm	**2nd 15cm**	**3rd 15cm**				
				N1	**N2**	**N3**				
Yellowish Red Sandy Silt	0.0									
	1.5		SPT DS	4	5	5	10			
	3.0		SPT DS	6	7	8	15			
Yellowish White Sandy Silt With Gravel	4.5		SPT DS	9	11	12	23			
	6.0		SPT DS	10	12	14	26			
Whitish Grayish Red Sandy Soil	7.5		SPT DS	13	15	17	32			
	9.0		SPT DS	14	18	20	38			
Grayish White CWR	10.5		SPT DS	13	19	21	40			
	12.0		SPT DS	15	21	23	44			
	13.5		SPT DS	15	18	20	38			
Yellowish White SR	15.0		SPT DS	17	19	22	41			
	16.5		SPT DS	50B/8cm	R		>100			
Yellowish White SDR	18.0		SPT DS	50B/1cm	R		>100			
	19.5		SPT DS	50B/5cm	R		>100			
	21.0		SPT DS	50B/2cm	R		>100			
	22.5		SPT DS	50B/1cm	R		>100			
Grayish Brown Fractured Rock	24.0		SPT DS	50B/1cm	R		>100			
	26.0		SPT DS	50B/1cm	R		>100			
Grayish Black Fractured Rock	27.0		SPT DS	50B/1cm	R		>100			
	28.5		SPT DS	50B/1cm	R		>100			
	30.0		SPT DS	50B/1cm	R		>100			

Note :

Bore hole was terminated at 30.0m depth below existing ground level

SPT - Standard penetration test Refusal means SPT N>50 R= Rebound HR:Hard Rock

DS - Undisturbed sample B=No. of blows SR: Soft Rock

MWR:Moderatly Weathered Rock CWR: completely weathered rock

BORE LOG SHEET

Project:	**Construction of Proposed Elevated Corridor from Old Madras Road from Swami Vivekananda Metro Station to Silk Board Junction on Hosur Road via Indiranagar-Domlur-Madiwala**
Client:	**Bengaluru Smart Infrastructure Limited (B Smile), # 108, 1st Floor, Annexe-2 Building, N.R. Square, Bengaluru - 560002.**

BH No:	**8**	**Ground Water Level : Not Encountered**	**Termination Depth:**	**30.0m**
Location	**Marked in Topographical Survey Drawing**		**Page No. 1**	**MSL : 895.278**

Description of Sub-soil stratum	Depth (m)	Legend	Sample	SPT TEST, Number of blows recorded			N value=N2+N3	Core Recovery, %	RQD %	Remarks
				1st 15cm	2nd 15cm	3rd 15cm				
				N1	N2	N3				
Reddish Sandy Silt	0.0									
	1.5		SPT DS	5	7	9	16			
	3.0		SPT DS	6	9	11	20			
	4.5		SPT DS	8	11	13	24			
Brownish Yellow Silt Sand	6.0		SPT DS	11	14	16	30			
Brownish to WhitishYellow Sandy Silt	7.5		SPT DS	14	16	19	35			
	9.0		SPT DS	17	25	29	54			
Brownish White Sandy Silt	10.5		SPT DS	19	26	32	58			
	12.0		SPT DS	18	26	35	61			
Yellowish White Silty Sand	13.5		SPT DS	20	26	40	66			
Whitish to Brownish Yellow Sandy Silt	15.0		SPT DS	12	22	30	52			
	16.5		SPT DS	16	26	36	62			
Grayish Brown Sandy Silt	18.0		SPT DS	12	15	16	31			
Whitish Yellow Sandy Silt	19.5		SPT DS	17	25	35	60			
	21.0		SPT DS	50B/7cm	R		>100			
Yellowish White CWR	22.5		SPT DS	50B/6cm	R		>100			
Brownish Yellow CWR	24.0		SPT DS	50B/4cm	R		>100			
	25.5		SPT DS	50B/5cm	R		>100			
	27.0		SPT DS	50B/7cm	R		>100			
	28.5		SPT DS	50B/5cm	R		>100			
	30.0		SPT DS	50B/4cm	R		>100			

Note :

Bore hole was terminated at 30.0m depth below existing ground level

SPT - Standard penetration test — Refusal means SPT N>50 — R= Rebound — HR:Hard Rock

DS - Undisturbed sample — B=No. of blows — SR: Soft Rock

MWR:Moderatly Weathered Rock — CWR: completely weathered rock

BORE LOG SHEET

Project:	Construction of Proposed Elevated Corridor from Old Madras Road from Swami Vivekananda Metro Station to Silk Board Junction on Hosur Road via Indiranagar-Domlur-Madiwala
Client:	Bengaluru Smart Infrastructure Limited (B Smile), # 108, 1st Floor, Annexe-2 Building, N.R. Square, Bengaluru - 560002.

BH No:	9	Ground Water Level : Not Encountered	Termination Depth:		30.0m
Location	Marked in Topographical Survey Drawing		Page No. 1		MSL : 888.938

Description of Sub-soil stratum	Depth (m)	Legend	Sample	SPT TEST, Number of blows recorded			N value=N2+N3	Core Recovery, %	RQD %	Remarks
				1st 15cm	2nd 15cm	3rd 15cm				
				N1	N2	N3				
Yellowish Red Silty Sand	0.0									
	1.5		SPT DS	5	7	9	16			
	3.0		SPT DS	6	9	11	20			
Whitish Yellow Silty Sand	4.5		SPT DS	8	11	15	26			
	6.0		SPT DS	11	15	16	31			
	7.5		SPT DS	14	16	19	35			
	9.0		SPT DS	17	25	30	55			
Yellowish White Silty Sand	10.5		SPT DS	19	26	32	58			
	12.0		SPT DS	18	28	35	63			
	13.5		SPT DS	20	26	40	66			
Whitish Yellow CWR	15.0		SPT DS	12	22	30	52			
	16.5		SPT DS	16	26	36	62			
Brownish Yellow CWR	18.0		SPT DS	12	17	16	33			
	19.5		SPT DS	17	25	36	61			
	21.0		SPT DS	50B/8cm	R		>100			
	22.5		SPT DS	50B/7cm	R		>100			
	24.0		SPT DS	50B/6cm	R		>100			
	25.5		SPT DS	50B/5cm	R		>100			
	27.0		SPT DS	50B/7cm	R		>100			
	28.5		SPT DS	50B/6cm	R		>100			
	30.0		SPT DS	50B/5cm	R		>100			

Note :

Bore hole was terminated at 30.0m depth below existing ground level

SPT - Standard penetration test
Refusal means SPT N>50
R= Rebound
HR:Hard Rock
DS - Undisturbed sample
B=No. of blows
SR: Soft Rock
MWR:Moderatly Weathered Rock
CWR: completely weathered rock

2.6 Project Road Inventory

Existing Road Condition Survey has been carried out for the project corridor during the survey the existing width of carriageway with its type, width and type of footpath, width and type of drain, existing row width and the trees falling in the proposed alignment which are to be cut and to be trimmed are noted and listed below in the table.

Tree Details				
Sl. No.	**Cutting of Trees**	**Nos**	**Cutting the branches of Tree**	**Nos**
1	Tree Transplantation	37	Cutting of branches of trees and shrubs from the road way or with in R.O.W including disposal of wood and leaves to suitable location as per technical specification	**70**
2	Girth from 600mm to 900mm	28		
3	Girth from 900 mm to 1800mm	15		
4	Girth above 1800mm	09		
	Total	**89**		**70**

Road Inventory Survey Details

Sl. No.	Chainage (m)	Width of Carriageway in (m)			Total Width of Carriageway in (m)	Type of Drain		Width of Drain in (m)		Width of Footpath in (m)		Total EROW Width in (m)
		LHS	Median	RHS		LHS	RHS	LHS	RHS	LHS	RHS	
1	0+000	7.50	0.80	7.50	15.80	RCC	RCC	1.60	1.50	2.60	2.20	23.70
2	0+100	7.40	0.80	7.40	15.60	RCC	RCC	1.20	1.60	3.30	2.40	24.10
3	0+200	7.40	0.80	7.40	15.60	RCC	RCC	1.70	1.60	2.80	2.20	23.90
4	0+300	7.40	0.80	7.40	15.60	RCC	RCC	2.60	1.60	3.00	2.00	24.80
5	0+400	7.40	0.80	7.40	15.60	RCC	RCC	1.00	1.00	3.00	2.00	22.60
6	0+500	7.40	0.80	7.40	15.60	RCC	RCC	1.00	1.20	3.80	2.60	24.20
7	0+600	7.40	0.80	7.40	15.60	RCC	RCC	1.20	1.20	3.00	2.80	23.80
8	0+700	7.40	0.80	7.40	15.60	RCC	RCC	1.00	1.00	3.50	2.40	23.50
9	0+800	7.40	0.80	7.20	15.40	RCC	RCC	1.00	1.00	3.20	2.40	23.00
10	0+900	8.40	0.80	8.40	17.60	RCC	RCC	1.00	1.00	3.20	2.50	25.30
11	1+000	8.40	0.80	8.40	17.60	RCC	RCC	1.00	1.20	2.30	1.60	23.70
12	1+100	8.40	0.80	8.40	17.60	RCC	RCC	1.20	1.00	2.20	2.00	24.00
13	1+200	8.40	0.80	8.40	17.60	RCC	RCC	1.00	1.00	2.40	2.30	24.30
14	1+300	8.60	0.80	8.60	18.00	RCC	RCC	1.20	1.20	1.80	1.80	24.00
15	1+400	8.40	0.80	8.40	17.60	RCC	RCC	1.00	1.00	2.00	1.70	23.30
16	1+500	8.00	0.80	9.00	17.80	RCC	RCC	1.00	1.00	5.90	4.90	30.60

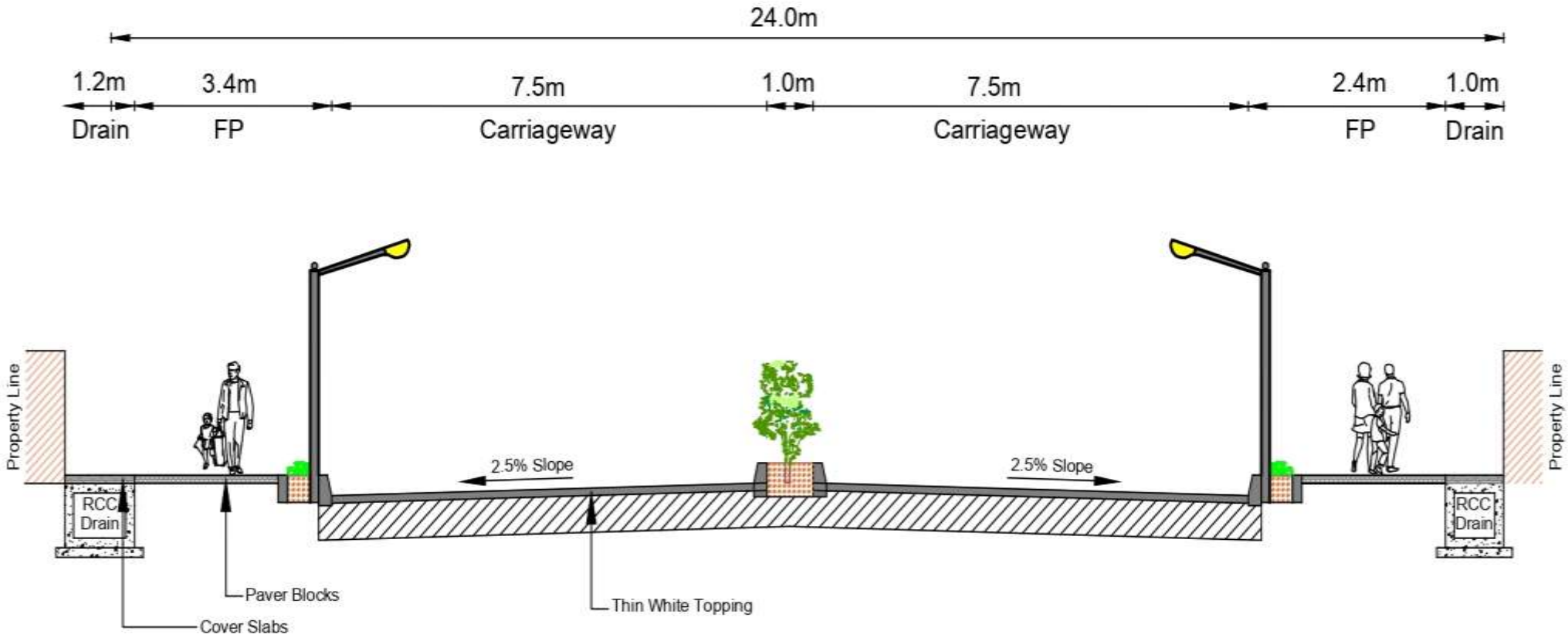
Sl. No.	Chainage (m)	Width of Carriageway in (m)			Total Width of Carriageway in (m)	Type of Drain		Width of Drain in (m)		Width of Footpath in (m)		Total EROW Width in (m)
		LHS	Median	RHS		LHS	RHS	LHS	RHS	LHS	RHS	
17	1+600	7.50	0.80	9.00	17.30	RCC	RCC	1.00	1.00	5.70	5.40	30.40
18	1+700	7.50	0.80	9.00	17.30	RCC	RCC	1.00	1.00	5.30	5.20	29.80
19	1+800	8.70	0.40	9.30	18.40	RCC	RCC	1.10	1.20	4.50	5.20	30.40
20	1+860	8.80	0.40	10.80	20.00	RCC	RCC	1.10	1.10	4.10	3.90	30.20
21	1+920	18.20			18.20	RCC	RCC	1.20	1.10	3.70	6.00	30.20
22	1+980	9.10	0.40	8.90	18.40	RCC	RCC	1.20	1.10	3.60	5.90	30.20
23	2+040	9.40	0.40	11.30	21.10	RCC	RCC	1.20	1.20	3.50	4.00	31.00
24	2+100	9.30	0.40	12.30	22.00	RCC	RCC	1.00	1.10	3.60	3.30	31.00
25	2+160	9.40	0.40	12.10	21.90	RCC	RCC	1.10	1.10	3.70	2.90	30.70
26	2+220	9.20	0.40	8.70	18.30	RCC	RCC	1.00	1.10	4.30	6.50	31.20
27	2+280	9.20	0.40	9.30	18.90	RCC	RCC	1.30	1.10	4.40	5.70	31.40
28	2+340	17.70			17.70	RCC	RCC	1.30	1.20	5.10	6.30	31.60
29	2+400	9.10	0.40	9.20	18.70	RCC	RCC	1.30	1.10	4.10	6.70	31.90
30	2+460	9.10	0.40	9.10	18.60	RCC	RCC	1.20	1.20	4.10	6.60	31.70
31	2+520	18.70			18.70	RCC	RCC	1.10	1.10	3.80	6.40	31.10
32	2+580	9.40	0.40	12.00	21.80	RCC	RCC	1.10	1.10	3.70	3.60	31.30
33	2+640	9.20	0.40	8.90	18.50	RCC	RCC	1.10	1.10	3.90	6.50	31.10
34	2+700	18.80			18.80	RCC	RCC	1.20	1.20	4.10	6.00	31.30
35	2+760	9.40	0.40	9.20	19.00	RCC	RCC	1.10	1.20	3.70	4.50	29.50
36	2+820	8.90	0.40	8.90	18.20	RCC	RCC	1.20	1.10	3.70	6.10	30.30
37	2+880	9.30	0.40	9.00	18.70	RCC	RCC	1.20	1.20	3.30	6.10	30.50
38	2+940	8.90	0.40	9.10	18.40	RCC	RCC	1.10	1.20	3.30	6.00	30.00
39	3+000	9.10	0.40	9.30	18.80	RCC	RCC	1.10	1.20	3.10	6.00	30.20
40	3+060	9.20	0.40	8.00	17.60	RCC	RCC	1.10	1.10	2.80	7.50	30.10
41	3+120	20.80			20.80	RCC	RCC	1.30	2.10	5.30	1.30	30.80
42	3+180	14.60	0.80	14.60	30.00	RCC	RCC	-	1.00	3.00	-	34.00
43	3+180 to 3+660 Existing Domlur Flyover					-	-	-	-	-	-	-
44	3+660	13.30	0.80	13.10	27.20	RCC	RCC	1.00	-	1.50	1.50	31.20
45	3+750	10.80	1.50	11.10	23.40	RCC	RCC	1.20	1.50	2.10	1.50	29.70
46	3+810	10.40	1.50	10.40	22.30	RCC	RCC	1.00	1.20	3.00	2.00	29.50
47	3+870	10.50	1.50	10.20	22.20	RCC	RCC	1.20	1.20	1.50	3.90	30.00
48	3+930	10.30	1.50	10.50	22.30	RCC	RCC	1.20	1.20	3.00	2.70	30.40

Sl. No.	Chainage (m)	Width of Carriageway in (m)			Total Width of Carriageway in (m)	Type of Drain		Width of Drain in (m)		Width of Footpath in (m)		Total EROW Width in (m)
		LHS	Median	RHS		LHS	RHS	LHS	RHS	LHS	RHS	
49	3+990	10.50	1.50	10.50	22.50	RCC	RCC	1.20	1.20	2.50	2.50	29.90
50	4+050	11.20	1.50	10.50	23.20	RCC	RCC	1.20	1.20	1.60	3.00	30.20
51	4+110	10.30	1.50	10.70	22.50	RCC	RCC	1.20	1.20	2.00	2.70	29.60
52	4+170	10.00	1.50	10.40	21.90	RCC	RCC	1.50	1.50	2.40	2.60	29.90
53	4+230	10.50	1.50	10.20	22.20	RCC	RCC	1.50	1.50	2.30	3.20	30.70
54	4+290	10.50	1.50	10.50	22.50	RCC	RCC	1.20	1.50	5.00	2.60	32.80
55	4+350	10.50	1.50	10.50	22.50	RCC	RCC	1.30	1.30	2.60	2.80	30.50
56	4+410	10.50	1.50	10.50	22.50	RCC	RCC	1.30	1.30	3.50	2.30	30.90
57	4+470	10.10	2.00	10.50	22.60	RCC	RCC	1.10	1.10	3.80	3.40	32.00
58	4+530	10.80	2.20	11.20	24.20	RCC	RCC	1.10	1.10	5.00	5.40	36.80
59	4+590	10.60	2.20	12.00	24.80	RCC	RCC	1.10	1.10	5.10	6.40	38.50
60	4+650	10.60	2.20	12.00	24.80	RCC	RCC	1.10	1.10	5.00	6.00	38.00
61	4+710	10.60	2.20	12.00	24.80	RCC	RCC	1.10	1.10	4.70	3.50	35.20
62	4+770	10.60	2.20	10.30	23.10	RCC	RCC	1.20	1.30	2.50	2.70	30.80
63	4+830	11.20	2.20	10.80	24.20	RCC	RCC	1.20	1.10	2.40	3.00	31.90
64	4+890	11.40	2.20	12.20	25.80	RCC	RCC	1.20	1.20	2.50	3.20	33.90
65	4+950	11.80	2.20	12.00	26.00	RCC	RCC	1.20	1.20	3.20	3.00	34.60
66	5+010	11.80	2.20	12.00	26.00	RCC	RCC	1.20	1.20	3.20	3.10	34.70
67	5+070	10.80	2.20	10.70	23.70	RCC	RCC	1.20	1.20	2.80	3.00	31.90
68	5+130	10.10	2.20	10.00	22.30	RCC	RCC	1.20	1.10	2.80	3.00	30.40
69	5+190	9.00	2.20	9.00	20.20	RCC	RCC	-	-	1.20	1.30	22.70
70	5+250	10.00	2.20	10.00	22.20	RCC	RCC	-	1.10	4.50	3.50	31.30
71	5+310	10.00	2.20	10.00	22.20	RCC	RCC	-	1.10	4.50	3.50	31.30
72	5+370	9.90	2.20	9.90	22.00	RCC	RCC	-	1.10	6.80	4.00	33.90
73	5+430	10.00	2.20	9.90	22.10	RCC	RCC	-	1.10	3.20	5.70	32.10
74	5+490	10.00	2.20	10.00	22.20	RCC	RCC	-	1.10	3.00	5.70	32.00
75	5+550	10.00	2.20	10.00	22.20	RCC	RCC	1.40	1.10	3.00	4.40	32.10
76	5+610	10.00	2.20	10.00	22.20	RCC	RCC	1.40	1.10	2.80	4.20	31.70
77	5+670	10.00	2.20	10.00	22.20	RCC	RCC	1.50	1.00	3.00	3.50	31.20
78	5+730	10.00	2.20	10.00	22.20	RCC	RCC	1.50	1.00	2.70	3.00	30.40

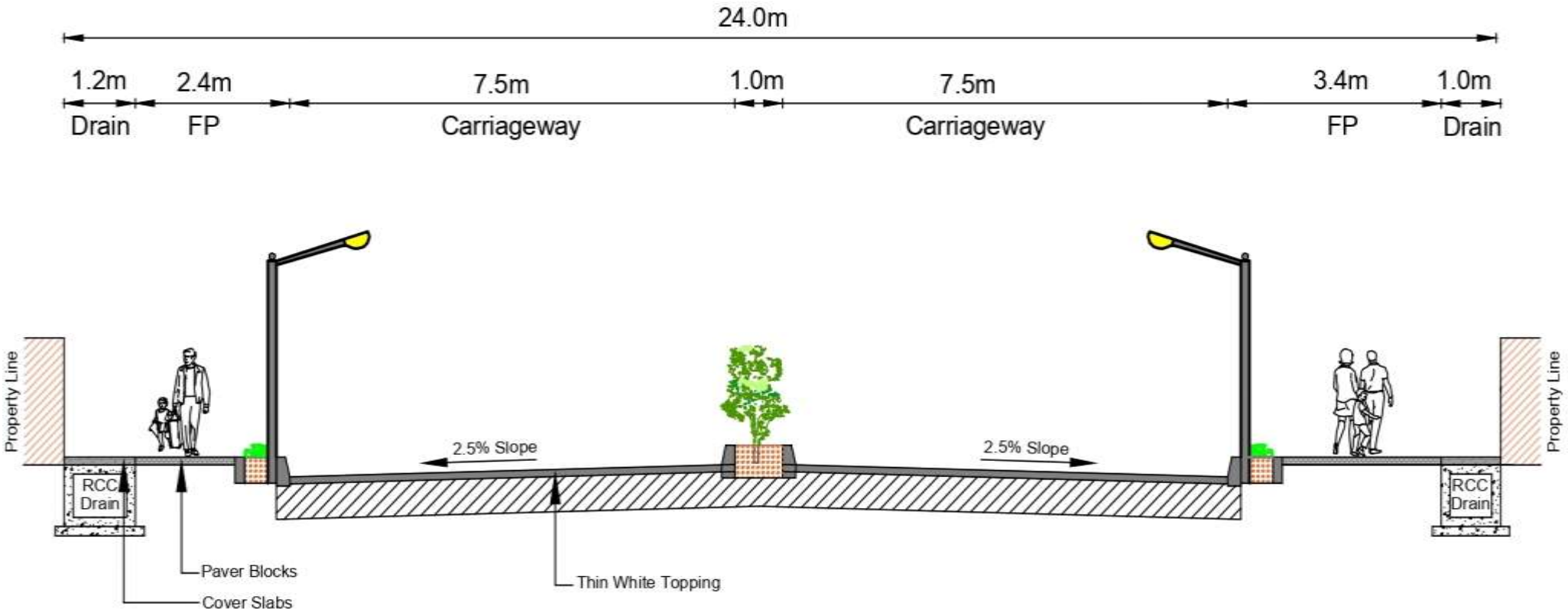
Sl. No.	Chainage (m)	Width of Carriageway in (m)			Total Width of Carriageway in (m)	Type of Drain		Width of Drain in (m)		Width of Footpath in (m)		Total EROW Width in (m)
		LHS	Median	RHS		LHS	RHS	LHS	RHS	LHS	RHS	
79	5+790	10.00	2.20	10.00	22.20	RCC	RCC	1.50	1.00	2.60	3.00	30.30
80	5+850	10.00	2.20	10.00	22.20	RCC	RCC	1.00	1.00	3.00	3.20	30.40
81	5+910	10.00	2.20	10.00	22.20	RCC	RCC	1.00	1.00	2.80	2.60	29.60
82	5+970	10.00	2.20	10.00	22.20	RCC	RCC	1.00	1.10	3.10	3.20	30.60
83	6+030	10.30	2.20	10.40	22.90	RCC	RCC	1.00	1.00	4.70	3.80	33.40
84	6+090	11.30	2.20	11.20	24.70	RCC	RCC	1.00	1.00	5.00	3.20	34.90
85	6+150	11.20	2.20	11.30	24.70	RCC	RCC	1.00	1.00	4.20	3.40	34.30
86	6+210	11.50	2.20	11.10	24.80	RCC	RCC	1.00	1.00	3.20	3.00	33.00
87	6+270	10.80	2.20	10.50	23.50	RCC	RCC	1.00	1.00	2.80	3.20	31.50
88	6+330	9.50	-	8.30	17.80	RCC	RCC	1.00	1.00	3.50	3.00	26.30
89	6+390	10.50	-	10.00	20.50	RCC	RCC	1.20	1.20	2.30	0.00	25.20
90	6+450	6.30	-	11.70	18.00	RCC	RCC	1.20	1.20	0.00	1.50	21.90
91	6+510	6.80	-	9.70	16.50	RCC	RCC	1.20	1.20	2.00	1.50	22.40
92	6+570	9.20	-	8.70	17.90	RCC	RCC	1.20	1.20	2.40	1.50	24.20
93	6+630	9.70	-	7.70	17.40	RCC	RCC	1.50	1.20	0.00	1.50	21.60
94	6+690	7.70	-	8.00	15.70	RCC	RCC	2.00	1.20	0.00	1.50	20.40
95	6+750	7.70	-	11.20	18.90	RCC	RCC	2.00	1.20	0.00	1.50	23.60
96	6+810	7.80	-	10.30	18.10	RCC	RCC	2.00	1.20	0.00	0.00	21.30
97	6+900	10.00	-	7.10	17.10	RCC	RCC	1.20	1.20	3.00	2.70	25.20
98	6+960	10.50	-	7.20	17.70	RCC	RCC	1.20	1.20	3.00	2.60	25.70
99	7+020	10.10	-	8.10	18.20	RCC	RCC	1.20	1.20	3.00	2.70	26.30
100	7+100	11.10	2.50	10.30	23.90	RCC	RCC	1.50	1.60	2.20	1.50	30.70
101	7+200	6.70	2.50	9.70	18.90	RCC	RCC	1.50	1.50	1.20	1.90	25.00
102	7+300	11.40	2.50	10.20	24.10	RCC	RCC	1.30	1.50	2.30	1.30	30.50
103	7+400	11.60	2.50	9.70	23.80	RCC	RCC	1.20	1.60	2.10	3.70	32.40
104	7+500	10..9	2.50	10.30	12.80	RCC	RCC	1.50	1.60	2.80	1.90	20.60
105	7+600	11.20	2.50	11.50	25.20	RCC	RCC	1.50	1.60	2.20	2.10	32.60
106	7+700	11.50	2.50	9.70	23.70	RCC	RCC	1.40	1.60	2.70	2.50	31.90
107	7+800	10.20	2.50	10.30	23.00	RCC	RCC	1.60	1.60	2.40	2.70	31.30
108	7+900	10.60	2.50	10.20	23.30	RCC	RCC	1.60	1.60	3.40	2.00	31.90
109	8+000	12.70	2.50	10.80	26.00	RCC	RCC	1.50	1.10	2.20	1.00	31.80
110	8+100	12.80	2.50	8.10	23.40	RCC	RCC	1.50	-	2.80	2.50	30.20

Sl. No.	Chainage (m)	Width of Carriageway in (m)			Total Width of Carriageway in (m)	Type of Drain		Width of Drain in (m)		Width of Footpath in (m)		Total EROW Width in (m)
		LHS	Median	RHS		LHS	RHS	LHS	RHS	LHS	RHS	
111	8+200	13.50	2.50	8.90	24.90	RCC	RCC	1.50	-	1.80	2.80	31.00
112	8+300	9.50	2.50	9.10	21.10	RCC	RCC	2.40	1.30	2.00	2.40	29.20
113	8+400	6.70	12.00	10.20	28.90	RCC	RCC	-	-	1.50	1.00	31.40
114	8+500	6.40	19.10	5.10	30.60	RCC	RCC	-	-	-	-	30.60
115	8+600	24.40			24.40	RCC	RCC	-	-	1.70	3.80	29.90
116	8+700	10.80	0.70	10.70	22.20	RCC	RCC	1.40	1.00	2.20	3.10	29.90
117	8+800	10.00	0.70	11.10	21.80	RCC	RCC	1.40	2.20	3.50	1.20	30.10
118	8+900	12.60	0.70	14.10	27.40	RCC	RCC	1.70	-	-	0.90	30.00
119	9+000	8.40	0.70	14.50	23.60	RCC	RCC	1.70	-	-	2.50	27.80
120	9+100	9.50	0.70	14.20	24.40	RCC	RCC	1.80	-	-	3.00	29.20
121	9+200	8.40	0.70	11.90	21.00	RCC	RCC	1.90	-	0.90	2.60	26.40
122	9+300	16.00	0.40	13.90	30.30	RCC	RCC	1.50	1.40	2.30	-	35.50
123	9+400	15.50	1.00	18.00	34.50	RCC	RCC	1.20	1.50	1.50	0.70	39.40
124	9+500	17.70	0.90	19.10	37.70	RCC	RCC	1.30	1.20	0.60	4.10	44.90
125	9+600	75.80			75.80	RCC	RCC	-	11.5	-	1.10	88.40
126	9+700	70.20			70.20	RCC	RCC	-	8.80	1.40	2.40	82.80
127	9+800	82.70			82.70	RCC	RCC	-	5.70	-	-	88.40
128	9+900	66.00			66.00	RCC	RCC	-	1.80	-	0.90	68.70
129	10+000	59.20			59.20	RCC	RCC	-	1.80	-	0.70	61.70
130	10+100	57.30			57.30	RCC	RCC	-	2.10	-	0.80	60.20
131	10+200	54.20			54.20	RCC	RCC	-	1.90	-	0.50	56.60
132	10+300	52.90			52.90	RCC	RCC	-	1.20	-	1.40	55.50
133	10+400	57.70			57.70	RCC	RCC	-	1.20	-	1.60	60.50
134	10+500	67.90			67.90	RCC	RCC	-	1.00	-	1.90	70.80
135	10+600	73.40			73.40	RCC	RCC	-	-	-	-	73.40
136	10+700	54.90			54.90	RCC	RCC	-	1.00	-	2.10	58.00
137	10+800	55.70			55.70	RCC	RCC	-	1.00	-	2.20	58.90
138	10+900	58.60			58.60	RCC	RCC	-	1.00	-	4.10	63.70
139	10+975	62.10			62.10		-	-	1.10	-	3.40	66.60

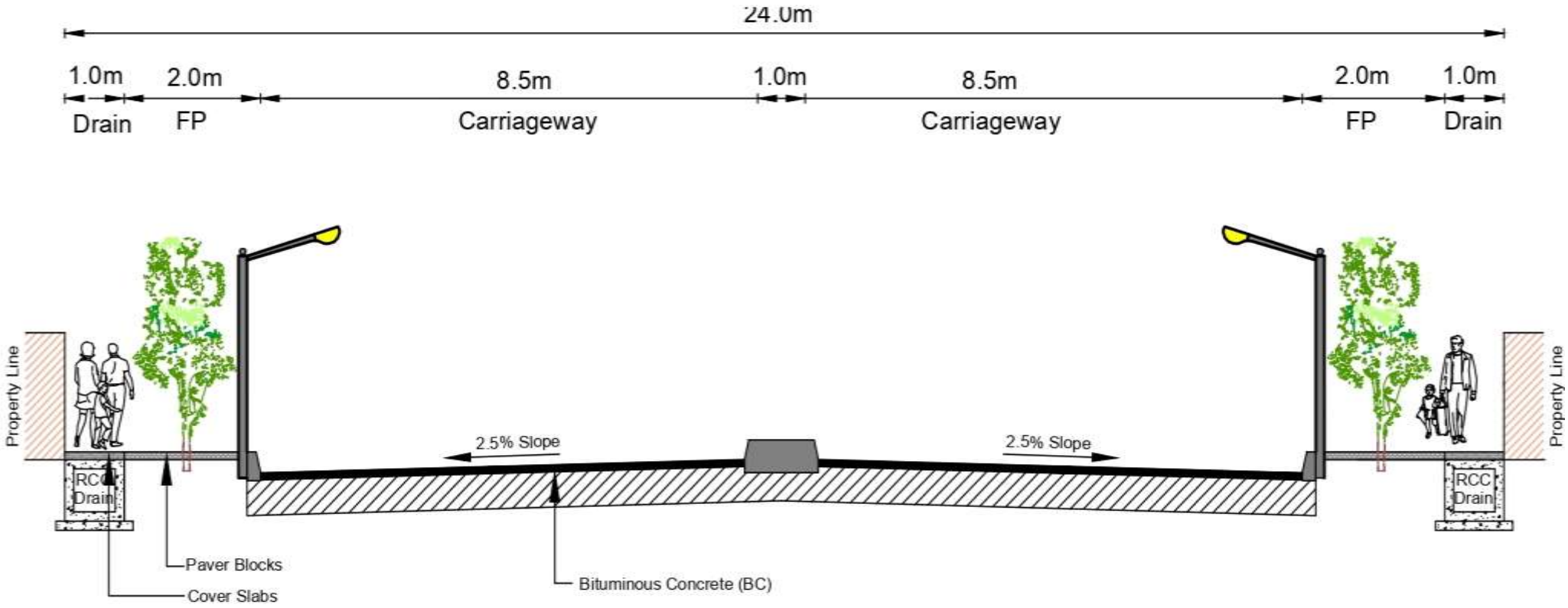
2.7 Existing cross section of the project road with Chainages



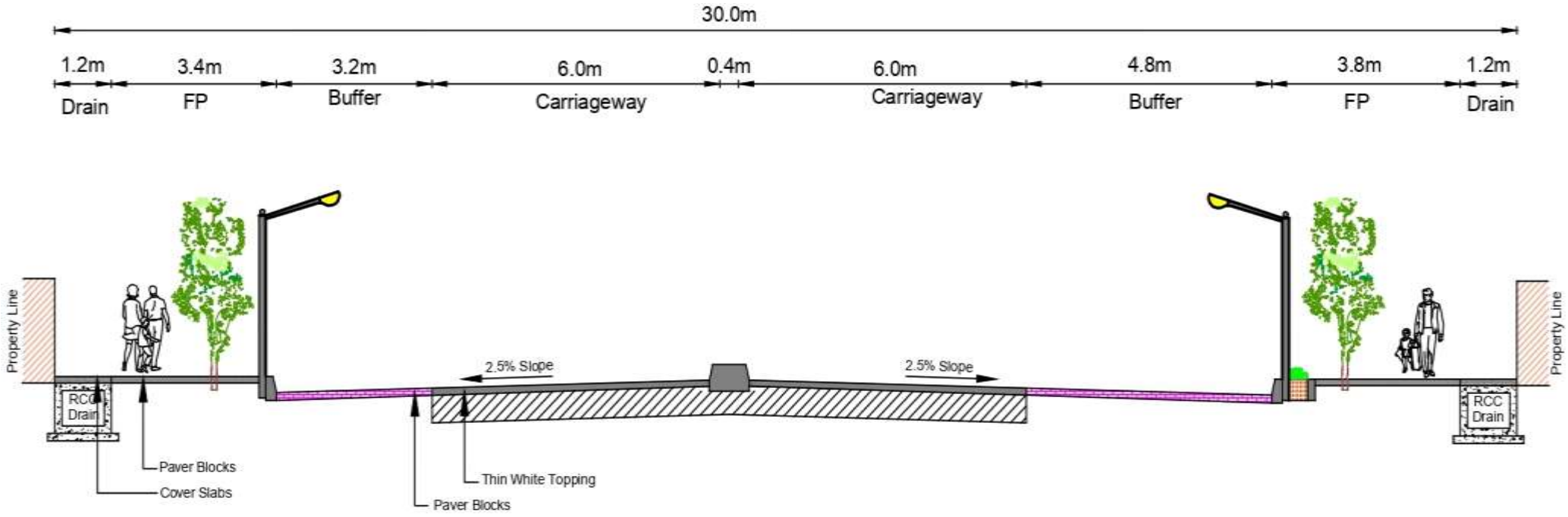
Existing Cross Section @ CH: 0+100



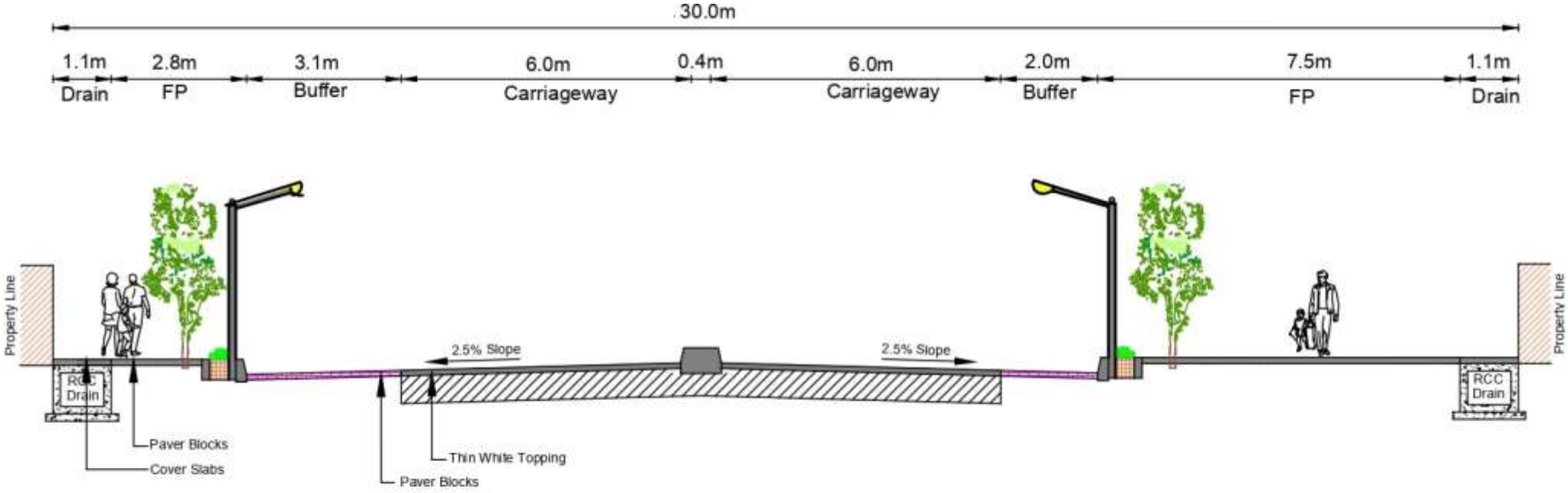
Existing Cross Section @ CH: 0+480



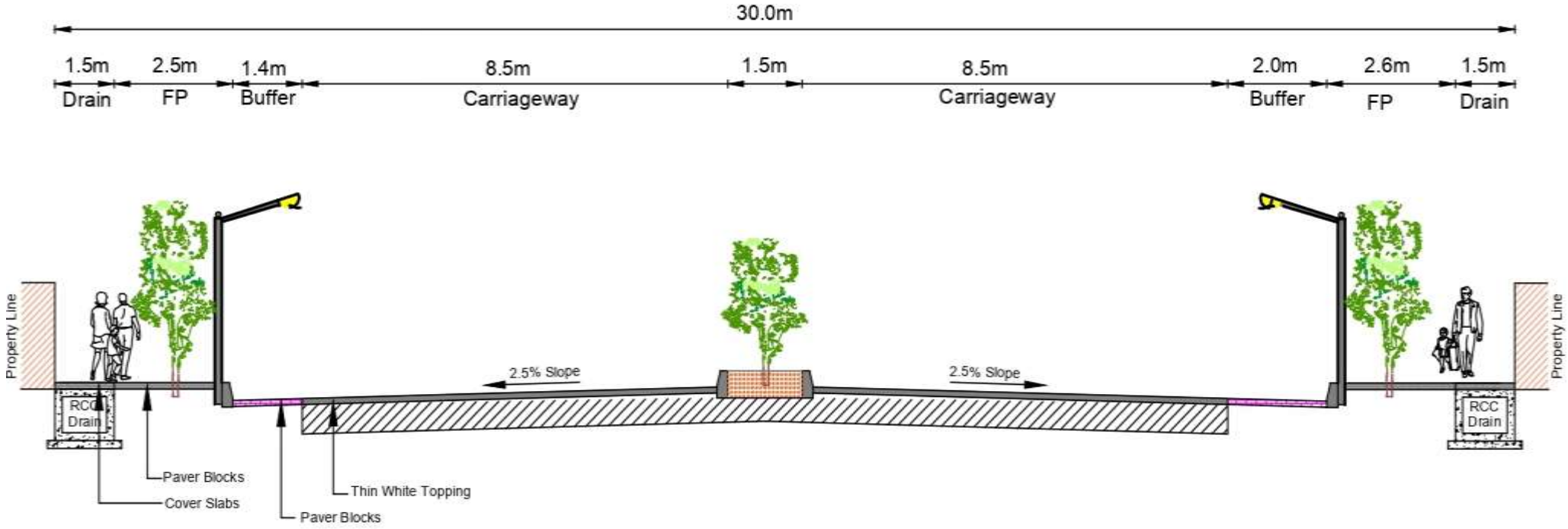
Existing Cross Section @ CH: 1+200



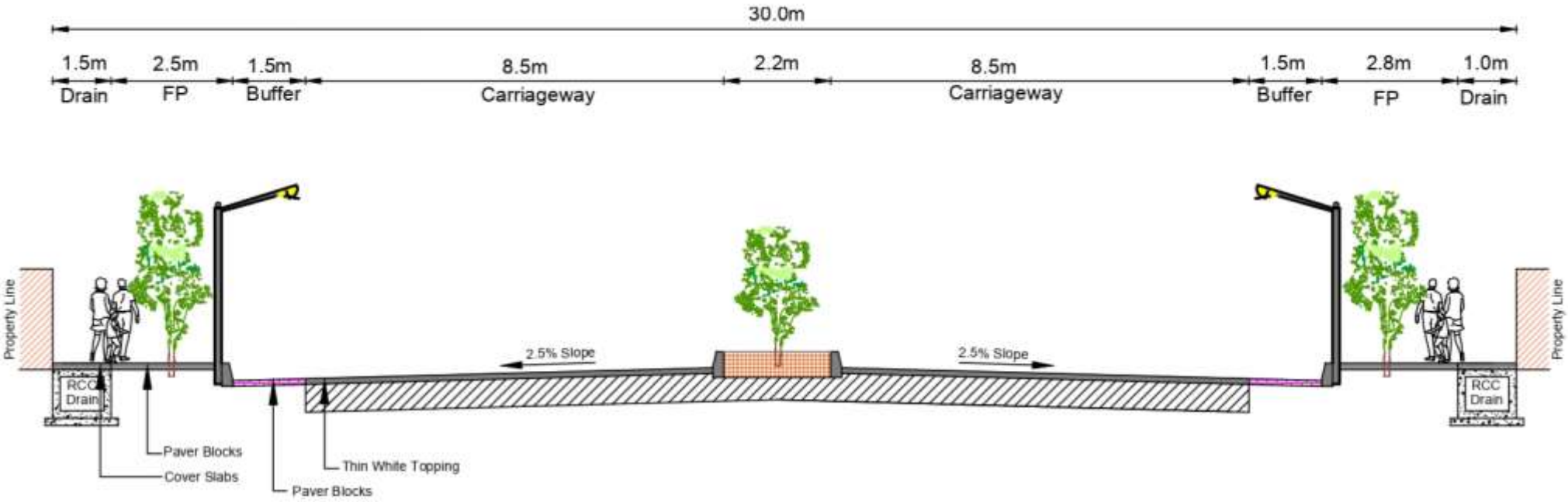
Existing Cross Section @ CH: 2+050



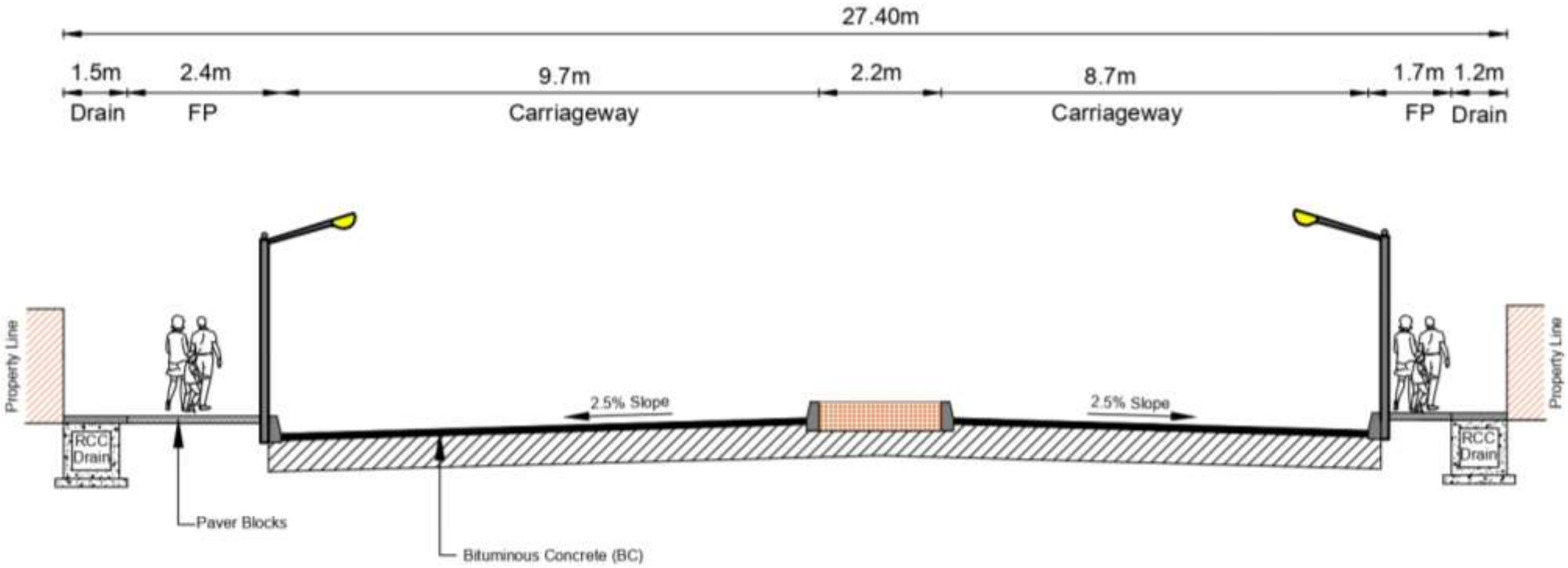
Existing Cross Section @ CH: 3+070



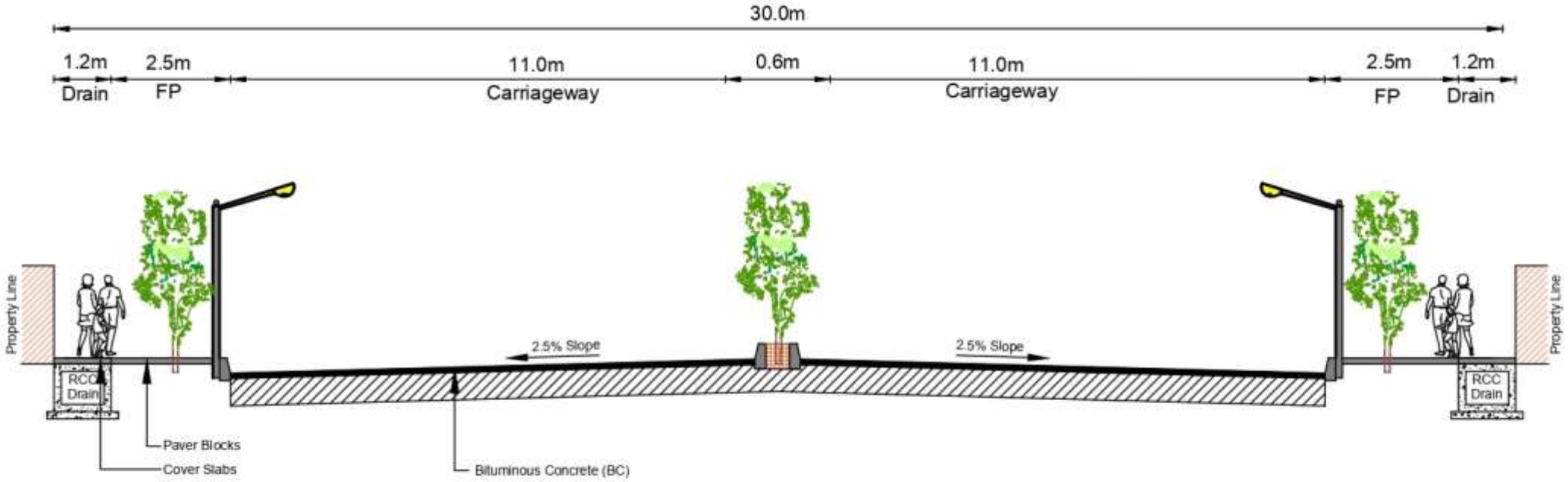
Existing Cross Section @ CH: 4+200



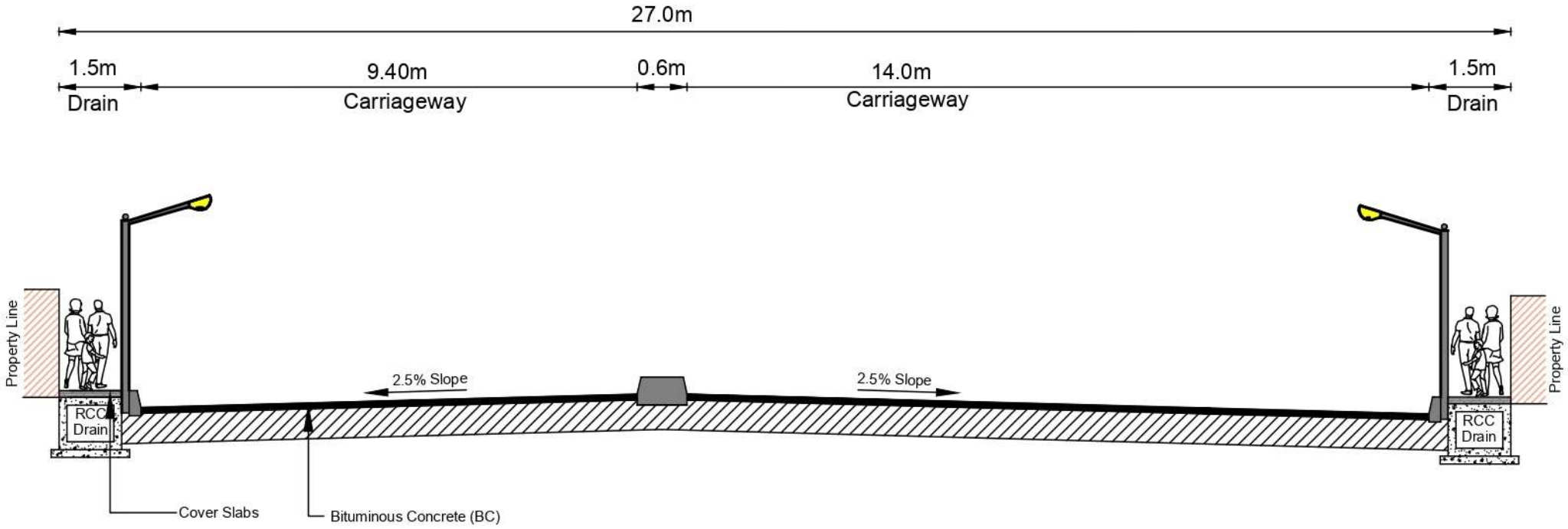
Existing Cross Section @ CH: 5+650



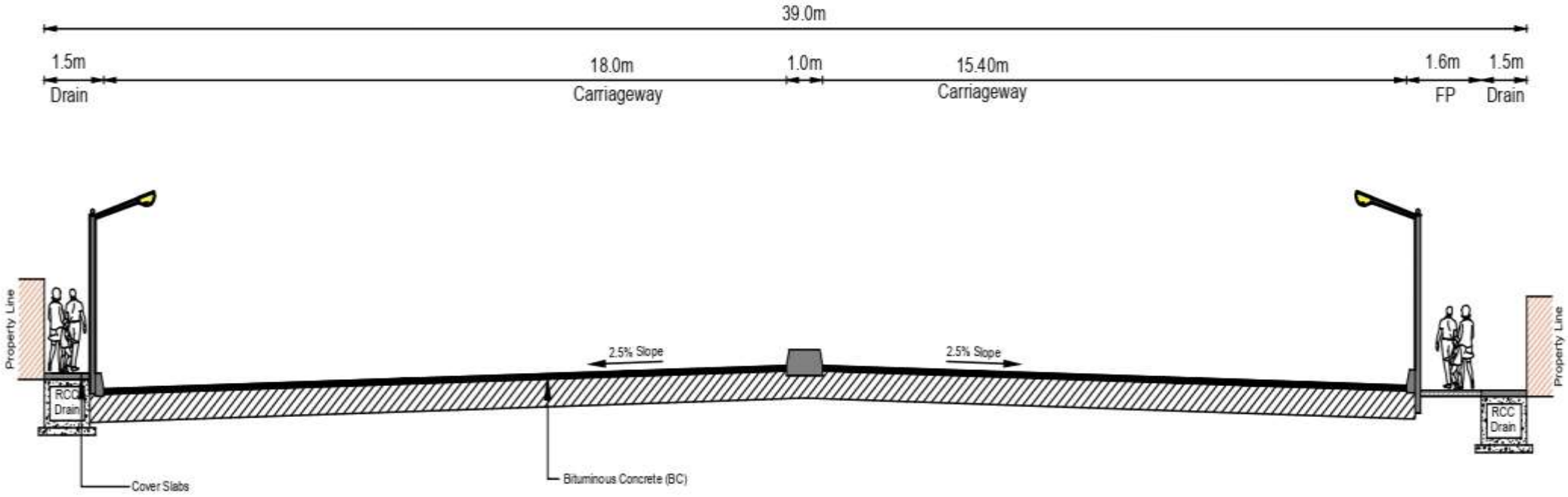
Existing Cross Section @ CH: 6+580



Existing Cross Section @ CH: 8+700



Existing Cross Section @ CH: 9+100



Existing Cross Section @ CH: 9+400

2.8 Project Road Images

The reconnaissance survey was made before detailed design and existing condition of site is captured through Photos and is apexes in theFigure 2-3below.

Swamy Vivekananda Metro Station on

Old Madras Road starting location

 Chinmaya Mission Hospital (CMH) On 80 Feet Road	 Chinmaya Mission Hospital (CMH) On 80 Feet Road
 CMH Park on 100 Feet Road	 CMH Park on 100 Feet Road

Start of Domlur Existing Flyover

Loop from Domlur Flyover towards Domlur

Loop from Domlur Flyover towards HAL

End of Domlur Flyover

Google Image of Domlur Flyover

Arial View of Domlur Flyover

Nearer to Domlur Junction

Sky walk at near to Domlur Junction

At Indiranagara Road

Existing Tree on either side of Road and needs Branches to be cut.

Existing Tree on either side of Road and needs Branches to be cut.	Existing Tree on either side of Road and needs Branches to be cut.

Urban Ladder

Sony World Signal

Sony World Signal

Madiwala Underpass on Hosur Road

Madiwala Underpass on Hosur Road

Hosur Road

Hosur Road

Hosur Road

Hosur Road

Figure 2-3 Existing Conditions of Project Road

A view of the construction of the metro lane in the second level to cross the existing Hosur flyover to connect with the Banashankari metro lane.	View of Ramp towards Hosur road
The existing down ramp to the HSR layout side and the elevated metro under construction in the middle of the outer ring road.	The existing down ramp to the HSR layout side and the BMTC bus stand on the right.
A view of the elevated road construction by BMRCL to cross the existing HSR flyover.	A view of Up ramp with RE Wall under construction

Up ramp under construction for the Traffic from Marathalli side to Banashankari	Parallel construction of elevated metro lane and approach to elevated road by BMRCL

3 Methodology and Design Standards

3.1 General

After the study of the Traffic survey details and Interference at the project road, an arrangement best suiting to the traffic pattern is proposed for improving the traffic situation. Proposal is evolved giving due consideration to minimize land acquisition. All the site constraints have been taken care while formulating the improvement scheme.

Efforts have been made to create a conflict-free situation within the possible limits of the right of way, the main objective of which is to greatly improve the current situation and expand the flow of traffic as much as possible.

Current and future traffic growth pattern, location of bus stops, intersection, environmental impact etc. are considered. Thereafter, a traffic survey to estimate the future population of traffic is conducted in order to determine the number of lanes in each direction. The planned layout of the flyover is carefully chosen to avoid disturbance to traffic and maximize the decongestion potential.

3.2 Study of Existing Project Road

The Project road has been studied and the starting point of the project road is a diversion from the busiest road of National Highway No.-44 which is part of the arterial city road.

K.R. Puram, also known as Krishnarajapuram, is a prominent locality in Bengaluru, located in the eastern part of the city on National Highway 44 (NH-44). Specifically, the Peenya – Hebbal-K.R. Puram-Hosur road, is a part of NH-44. Traffic flow on this road turn onto Project Road at Swami Vivekananda Metro Station and proceed to Hosur Road via Silk Board Junction.

Added to the above, the Hebbel flyover in Bengaluru is part of the National Highway 7 (NH 7), specifically at the intersection of NH 7 and the Outer Ring Road (ORR). It is a crucial junction for traffic entering and exiting the city from the north. This traffic also connecting to the Project Road on the northeast through the ORR to lead towards Hosur.

After analyzing the traffic and road inventory survey of the project road, the improvement proposal was considered and a detailed study was carried out to suggest a suitable concept of proposal for the elevated road.

3.3 Augmentation of Traffic capacity

The proposed project road, extending from **Swami Vivekananda Metro Station on Old Madras Road to Silk Board Junction on Hosur Road via Indiranagar–Domlur–Ejipura–Koramangala–Madiwala**, is located in the **southeastern part of Bengaluru**, close to the **Central Business District (CBD)**.

It is surrounded by well-established localities:

a) **West**: Ulsoor

b) **South**: Domlur

c) **East**: Vimanapura

d) **North**: Baiyappanahalli

Situated in the heart of the city, **Indiranagar** enjoys strong connectivity through Old Madras Road, the Namma Metro, and southern links to Ejipura, Koramangala, and Silk Board towards Hosur Road.

Need for Capacity Augmentation

a) The CBD and adjoining areas face **high traffic demand**, requiring augmentation of arterial road capacity.

b) Indiranagar exhibits one of the more balanced road densities in the city, making it a strategic corridor for intervention.

c) While **at-grade augmentation** is the default option, **land acquisition constraints** along the project road necessitate consideration of **elevated road solutions**.

Strategic Importance of the Elevated Corridor

a) Vehicles from **Hebbal via ORR**, **Baiyappanahalli Railway Terminal**, **KR Puram via Old Madras Road**, and **Halasuru/MG Road** can directly access Silk Board Junction once the elevated corridor is implemented.

b) A **flyover connecting Indiranagar to Silk Board via Ejipura** will address severe congestion on the Inner Ring Road.

c) Current delays at signalized junctions significantly impact commuting time and fuel efficiency.

d) The elevated corridor will provide a **faster, more direct route**, reducing travel time and improving traffic flow.

Broader Impact

Elevated corridors are not just local solutions; they serve as **critical connectors across urban regions**, linking different parts of the city and supporting national-level mobility. Such infrastructure projects act as **pillars of urban and economic growth**, strengthening both city-level and country-level development.

3.4 Structural type Options

Depending on span length, space availability, construction speed requirements, traffic management constraints, machinery and material movement limitations, and environmental considerations, one of the following structural types is selected for elevated corridors after evaluating their advantages and disadvantages:

i. Cast-in-situ on staging
ii. Precast at site or in casting yard, then erected or launched
iii. Segmental construction (cast-in-situ or precast)
iv. Incremental launching (push-in method)

For the superstructure, continuous spans are preferred as they reduce structural depth, improve riding quality and durability, and enhance aesthetics. Minimizing substructure depth also helps reduce the overall flyover length.

Segmental construction is often adopted in urban situations to facilitate smooth traffic flow during construction and to accelerate project timelines.

The following superstructure options were studied to meet IRC standards and arrive at the most suitable, economical, and site-specific solution:

a) Elevated road with precast I-girder
b) Elevated road with full-span precast box girder
c) Elevated road with segmental precast box girder
d) Elevated road with UHPFRC U-girder

3.4.1 Elevated Road with Pre-cast I- Girder.

Elevated roads using precast I-girders and box girders offer advantages such as faster construction, reduced on-site labor, and improved quality control. I-girders, with their simple I-shaped form, are economical and lighter for shorter spans. However, they have limited torsional stiffness, require deeper sections as spans increase, and involve cumbersome transport and launching operations. These factors can lead to longer construction timelines and higher substructure costs when applied to extended urban corridors. For this reason, while I-girders remain suitable for limited span applications, modern alternatives such as precast PSC box girders, double-T girders, or UHPFRC girders are generally preferred for elevated roads, as they provide greater efficiency, durability, and speed of construction.

3.4.2 Elevated road with Box Girder with full span precast

Simple box girders are efficient structural forms for spans up to 60 m, whether in simply supported or continuous construction. They also have wide applicability for longer spans, particularly when segmental construction is adopted.

Box Girder: A closed, hollow section with two flanges and two or more webs.

a. Advantages:

i. High torsional resistance due to the enclosed section.
ii. Capable of spanning longer distances than I-girders for the same depth.
iii. Suitable for carrying larger loads and applications where torsional stiffness is critical.

b. Disadvantages:

i. More complex to precast and construct in full-span lengths compared to I-girders.
ii. Heavier for the same load-bearing capacity, leading to higher costs.

For time-bound mass rapid transit projects (metros, high-speed rail), full-span precast box girders are generally preferred over segmental precast box girders. They enable faster construction progress, minimize traffic disruption, and deliver superior quality since the entire girder is cast in one operation at ground level, avoiding segmental joints.

However, transporting and launching full-span precast box girders is significantly more challenging than segmental girders, especially in congested urban environments. Constraints include limited space, traffic management, movement of heavy machinery and materials, and environmental considerations. Specialized equipment such as molds, straddle carriers, bridge gantries, launching girders, and girder transporters is required, increasing capital costs. Despite these costs, the method offers substantial benefits in speed and quality.

In dense urban areas, bidder participation for full-span girder tenders is often limited due to traffic congestion and logistical difficulties. Considering these challenges, the full-span precast box girder option was not selected for this project. The photo showing launching of full span box girder is shown in Figure 3-1below.

Figure 3-1 Launching of Full span Box girder

3.4.3 Elevated road with Segmental pre-cast Box girder.

Full-span girders are designed to be launched in one piece, enabling faster construction progress, while segmental girders are built in multiple precast sections and are more adaptable to complex geometries.

The project road includes both straight and curved alignments, requiring careful design to ensure safety, comfort, and efficiency. A segmental box girder is particularly suitable for such geometry, as it offers advantages in handling combinations of straight and curved spans. Segmental girders are constructed from multiple precast segments joined together at the project site, whereas full-span girders are cast as a single continuous piece for the entire span.

Urban environments often present challenges for flyover construction, including traffic disruption, space limitations, and the need to work around existing infrastructure. Segmental precast box girders are well suited to overcome these constraints. They are widely adopted for urban flyovers due to their efficiency, speed of construction, and ability to accommodate complex geometries. In addition, they minimize traffic disruption, provide high quality control, and ensure long-term durability, making them an ideal choice for densely populated areas. A launching photo of the segmental pre-cast girder is shown in Figure 3-2 below.

Figure 3-2 Launching of Segmental elements of Box Girder

3.4.3.1 Segmental Box Girder Concept

A segmental box girder flyover is a bridge structure where hollow box-shaped girders are constructed from precast or cast-in-situ concrete segments, connected and post-tensioned to form a continuous superstructure. This method combines the strength and torsional resistance of box girders with the efficiency and adaptability of segmental construction, making it suitable for long spans and complex alignments.

For wide decks exceeding 15 m, single-cell box girders with struts supporting the deck cantilevers, or with internal struts to reduce slab spans, are preferred. These configurations avoid the need for multi-cell box girders, which are more difficult to construct. Such geometry is particularly encouraged in the design of the proposed 17.2 m wide elevated flyover.

As span length increases, girder depth also increases, requiring larger substructures and foundations. This leads to longer construction timelines and higher costs. In urban environments, where traffic growth and space constraints demand rapid solutions without land acquisition, segmental box girders provide efficiency and adaptability.

Recent advances in Ultra-High Performance Fiber-Reinforced Concrete (UHPFRC) technology allow spans of 70–100 m to be precast in thinner sections, reducing self-weight and minimizing substructure requirements. This results in faster construction and cost savings. While UHPFRC technology has been introduced in India and encouraged at the DPR stage, its adoption is still emerging.

Considering the site conditions and constraints of this project, the use of segmental precast box girders is not recommended at this juncture, though UHPFRC remains a promising option for future applications.

Project Site Visit for understanding new technology adopted for Flyover

A site visit to Nagpur, Maharashtra was conducted on 18-07-2025 along with departmental officials to study the new technology adopted in the ongoing flyover project in Nagpur city. The team visited the project site where construction activities were in progress, as well as the casting plant where girders were being manufactured. Observations included the processes of girder transportation to the project location and launching at site.

Detailed discussions were held with officials of the National Highways Authority of India (NHAI), the client for the project, and with the contractor to understand the challenges encountered during construction. Project details and photographs from the site visit are enclosed in this report.

Location	Nagpur, Maharastra
Date of Site Visit	18-07-2025
Name of the Project	Construction of Flyover from Indora Square to ShitalmataChowk, Nagpur in the state of Maharastra
Client	National Highway Authority of India, G 5&6 Sector 10, Dwaraka, New Delhi-110075
Contractor	Nagarjuna Construction Company Ltd. (NCC), NCC House, Madhapur, hydrabad-500081, Email: info@nccltd.in
Project Cost	760.76 Cr
Project Duration	24 months
Maintenance Period	10 Years
Length of the Elevated Corridor	8.90 Km
Width of Flyover	12.0m
Status of the project as on date	Under Construction

Photos

STOP Please Sound Horn NCC	

3.4.3.2 Ultra – High Performance Fiber- Reinforced Concrete U Girder

As Bengaluru Smart Infrastructure Limited (B-SMILE) advances towards building high-speed corridors with shorter implementation timelines, innovation and modernization are essential. Ultra-High Performance Concrete (UHPC) offers an ideal solution to this challenge. With compressive strengths ranging from 150 to 250 MPa, UHPC provides exceptional durability and mechanical performance, enabling the production of structural components that are lightweight and slender in section.

These qualities allow UHPC systems to be adopted more widely in elevated infrastructure, reducing dead load and improving efficiency. Compared to conventional cast-in-situ construction or precast systems using normal high-strength concrete, UHPC enables faster transportation and erection of longer precast elements with lower energy requirements.

The use of UHPC can also result in slimmer bridge piers than those required with conventional concrete, accelerating construction and freeing valuable ground space in metropolitan areas. This is particularly advantageous for elevated road projects, as it increases carriageway space and minimizes disruption to existing traffic

3.4.3.3 Making process of UHPFRC

The performance of Ultra-High Performance Fiber-Reinforced Concrete (UHPFRC) depends on achieving low porosity and optimized particle packing. Reducing porosity increases strength, durability, and resistance to environmental degradation. This is accomplished through:

a. Close packing of raw materials to minimize voids.
b. • Use of super plasticizers (HRWR additives) to reduce water demand while maintaining workability.
c. • Incorporation of finely ground reactive mineral admixtures to enhance density and performance.
d. • Low water-to-binder ratio (w/b), which is critical for achieving high strength and durability.

e. Composition:

f. • Cement content typically ranges from 800–1000 kg/m³, which provides very high strength but increases heat of hydration, shrinkage risk, and production costs.

g. • Fine aggregates are used with particle sizes between 150–800 μm.

h. • Inert fillers such as quartz powder (0.1–100 μm) improve packing density.

i. • Supplementary cementitious materials (SCMs) can reduce costs while maintaining performance.

Steel Fibers:

Steel fibers are added to improve ductility, toughness, and crack resistance. Optimal fiber dosage is essential — concentrations above 2% by volume provide limited additional benefit due to difficulties in uniform dispersion.

Mixing Process:

The mixing procedure must be carefully controlled to achieve uniformity and performance. Key considerations include:

a. Proper sequence of adding materials.

b. • Dry mixing of binders, fillers, and aggregates before introducing water and HRWR additives.

c. • Control of mixing time (typically 15–20 minutes), speed, and temperature.

d. • Ensuring homogeneous dispersion of fibers throughout the matrix.

3.4.3.4 Mix Proportioning and Mechanical Characterisation

It is important to note that **Ultra-High Performance Concrete (UHPC)** does not contain coarse aggregates. Instead, it relies on fine powders and fibers to achieve very high strength and durability. A typical proprietary UHPC mix is shown in the Figure 3-3 and Figure 3-4 below:

Sl. No.	Material	Kg/M^3
1	Fine Sand	1050
2	Portland Cement	1000
3	Silika Fume	231
4	Ground Quartz	211
5	Steel Fibres	160
6	High Range Water Reducer (HRWR)	32
7	Accelerator	35
8	Water	109
Total		**2828**

Table 3-1 Typical composition of proprietary UHPC mix

Sl. No.	Product	Conventional Concrete (CC)	High Performance Concrete (HPC)	Ultra – High Performance Concrete(UHPC)
1	Compressive strength(MPa)	5-50	50-120	120-250
2	Density(Kg/m3)	2300	2500	2900
3	Flexural strength h(MPa)	1-5	4-14	14-29
4	E-Modulus(GPa)	20-40	50-60	70-80
5	Thermal-Conductivity(W/mK)	2.0	1.5	1.5
6	Coeff. Of thermal expansion (K-1)	10x10-6	10x10-6	10x10-6

Table 3-2Comparison of mechanical properties: CC vs HPC vs UHPC

Figure 3-3 Photo of UHPFRC U Girder casted at site

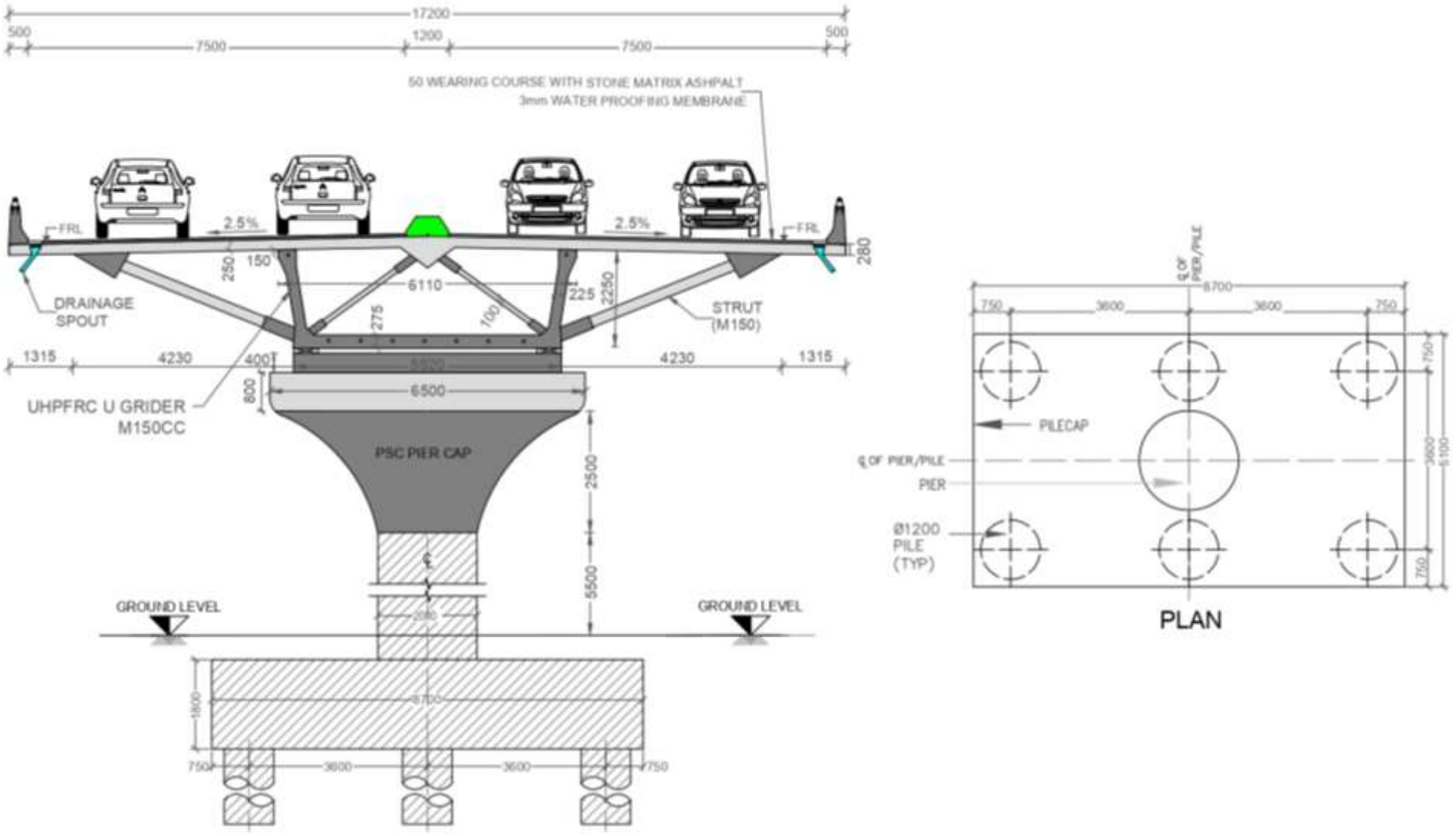


Figure 3-4 Photo of UHPFRC Strutted box Girder for 17.2m width

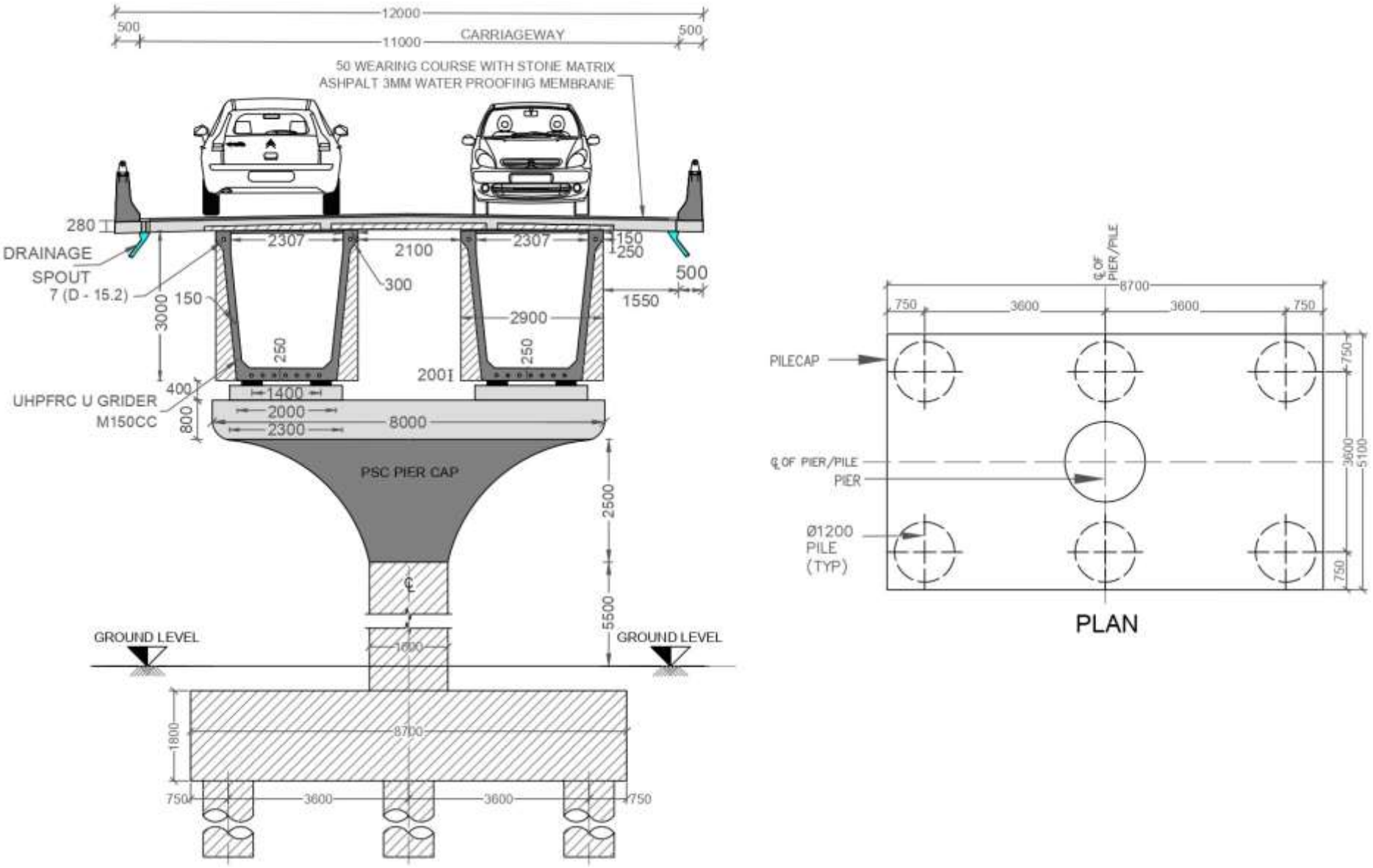


Figure 3-5 Photo of UHPFRC U Girder for 12.0m width

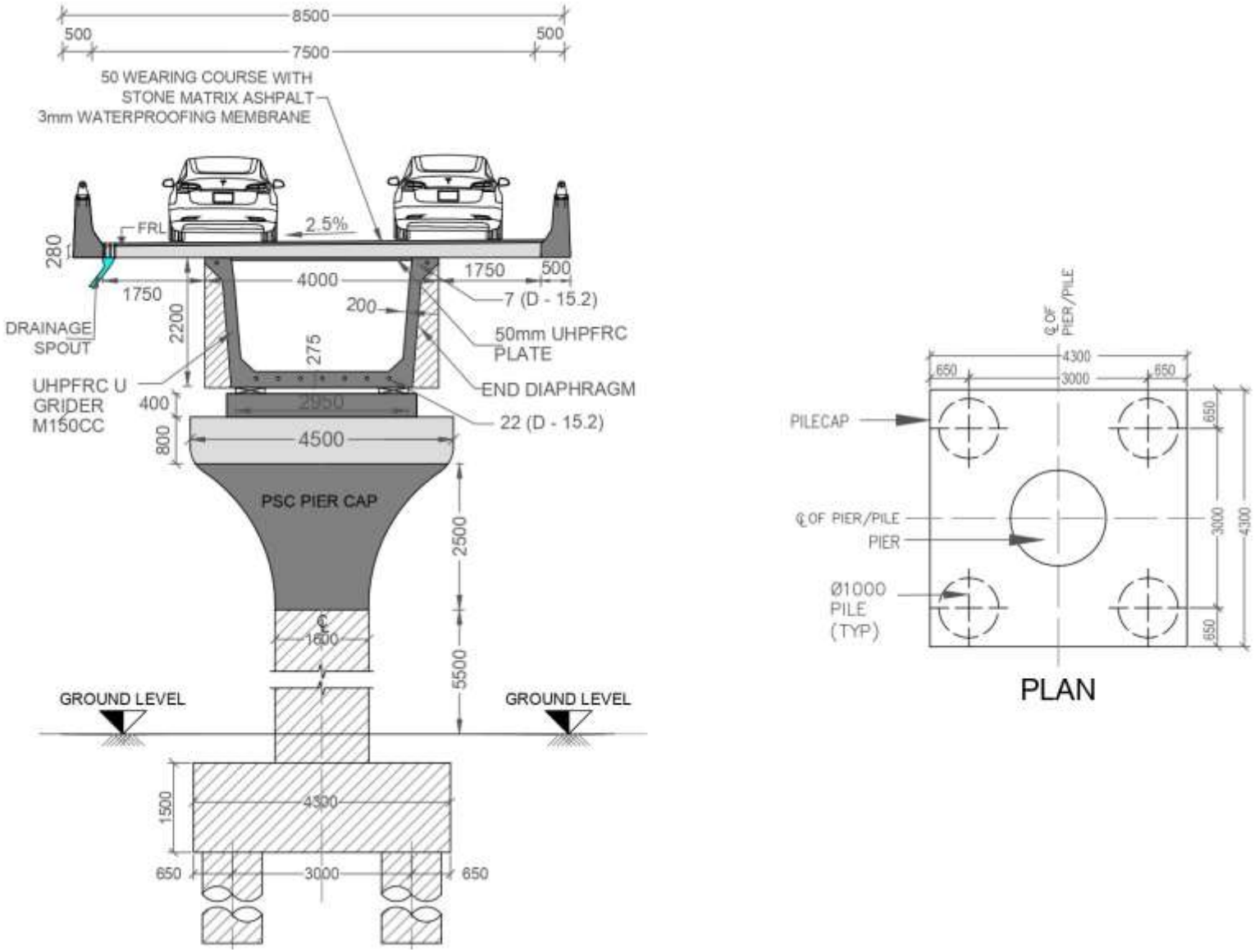


Figure 3-6 Photo of UHPFRC U Girder for 8.5m width

UHPFRC (Ultra-High-Performance Fiber-Reinforced Concrete) is an emerging material in bridge and flyover construction, valued for its superior mechanical properties and durability compared to conventional concrete. When combined with a strutted box girder design, UHPFRC offers several advantages: increased strength and stiffness, enhanced service life, potential for longer spans, improved aesthetics, and reduced construction time.

For this project, a UHPFRC U-box girder has been adopted for the 8.5 m carriageway, requiring a pier cap size of 4.5m. For the 17.2 m carriageway, however, a UHPFRC strutted box girder has been selected, which accommodates the same width with a pier cap size of only 6.5 m effectively halving the pier cap length compared to a U-box girder.

Due to its extremely high compressive and flexural strength, UHPC allows for smaller cross-sections with significantly reduced dead weight. Although UHPC is denser than conventional concrete, its flexural strength is several times higher, enabling lighter overall structures. Higher modulus values also mean reduced deflections compared to CC or HPC.

A comparative study shows that a 30 m span, 17.2 m wide segmental precast box girder requires a depth of 2.2 m, while a 45 m span, 17.2 m wide UHPFRC U-girder achieves the same depth of 2.2 m. This demonstrates that UHPC enables longer spans without increasing girder depth. The resulting reduction in dead weight proportionally decreases forces on the substructure, leading to savings in foundation size and cost.

Recommendation: For longer spans in urban flyovers, UHPFRC strutted box girders provide an ideal solution, combining efficiency, durability, and economy while minimizing substructure requirements.

3.4.3.5 Limited use of UHPFRC

Despite its many advantages, Ultra-High Performance Fiber-Reinforced Concrete (UHPFRC) has limited application in India at present. The reasons include:

a) High Cost and Proprietary Supply

i. UHPC is currently available in India only as a proprietary product, supplied by a few firms in pre-packed bags ready for mixing.

ii. This restricted supply chain results in very high costs, presently around ₹1,00,000 per cubic metre, making widespread adoption economically challenging.

b) Lack of National Design Standards

i. While countries such as France and Switzerland have developed detailed codes covering UHPC material specifications, testing, execution, and design standards, India has yet to establish comprehensive guidelines.

ii. The absence of Indian Standards (IS) or IRC-based design provisions is a major hindrance, as engineers and contractors lack formal references for design, quality control, and compliance.

3.4.3.6 NHAI Notification for Use of UHPFRC Structural elements

The National Highways Authority of India (NHAI), through Circular No. RW/NH-33049/01/2020 : S&R (B) Pt dated 22 February 2022, has emphasized the use of UHPFRC girders for longer spans of 50–100 m, compared to traditional girder systems typically limited to spans of around 30 m.

The Authority has recognized several advantages of UHPFRC girders:

a) Faster construction timelines.

b) Substantial savings in substructures and foundations.

c) Longer durability and service life.

d) Reduction in carbon footprint when applied to longer spans.

To promote adoption, the Government has permitted consultants to introduce modern UHPC structural elements in upcoming DPRs, particularly for National Highway viaduct projects exceeding 2000 m in length in urban areas, subject to evaluation of economic implications.

Furthermore, the Government has relaxed the application of conventional Indian codes for UHPFRC until specific IS/IRC standards are published. Concessionaires and EPC contractors are allowed to incorporate UHPFRC technology even in ongoing projects tendered prior to the circular, where conventional precast systems were originally specified.

Based on this national policy direction, the State Government can confidently align with the same approach, ensuring the best use of advanced technology for faster, more durable, and sustainable elevated infrastructure.

3.5 Recommendation of Structural elements for super structure

In order to achieve longer span bridges, Ultra-High Performance Fiber-Reinforced Concrete (UHPFRC) has proven effective in meeting design requirements compared to conventional reinforced concrete systems. By enabling spans of 50–100 m, UHPFRC reduces the number of foundations required. Since foundation works are among the most time-consuming activities in any project, this reduction provides a significant advantage in terms of construction speed and overall project delivery.

With these benefits—fewer foundations, faster construction, improved durability, and reduced carbon footprint—combined with the guidance of the NHAI Circular (22 February 2022) encouraging the use of UHPFRC girders, it is recommended that this methodology be adopted for the elevated corridor project. Accordingly, UHPFRC girders have been selected for implementation in this project.

3.5.1 Comparison of Cost by use of UHPFRC and HSC Concrete

Before recommending the structural elements for the superstructure, a comparative study was undertaken to evaluate potential savings in both cost and construction time. The analysis clearly demonstrates that adopting UHPFRC girders results in significant advantages over conventional alternatives.

The

Table 3-3 shown below shows that there will be a cost savings of 15 to 16% compare to use of UHPFRC girders. Substantial reduction of piles and pile cap in foundation and pier and pier cap in substructures can be seen in the Table 3-3 below.

Sl. No.	Description	UHPFRC Girder	HSC Box Girde	Savings wrt HSC Technology in terms of Number	Remarks Savings in %
1	Length of viaduct in Mtr including 12.0M, 17.2m, 8.5m & 7m CW Excluding approach	13049	13049		
2	Span arrangement in Mtr	45	30		
3	Deck slab Area of Carriageway width including12.0m+17.2m+, 8.5m & 7in Sqmt including RE Wall approaches	116852	116852		
4	No of Pile	1184	1834	650	35%
5	No of Pile cap	296	425	129	30%
6	No of Pier	296	425	129	30%
7	No of Pier cap	296	425	129	30%
8	Concrete qnty for Girder /Meter length	7.0cu/Rm for 20.2m Strutted box 2/RM for U Girder	12 /RM for 17m CW & 8 /RM for 8.5m CW		
9	Grade of Concrete for Girder	M-150	M-50		
10	Unit cost for the project	Based on KPWD CSR 2023-24 with the order of continuation			

		for the year 2025-26			
Sl. No.	**Description**	**UHPFRC Girder**	**HSC Box Girde**	**Savings wrt HSC Technology in terms of Number**	**Remarks Savings in %**
11	Unit rate for Girder concrete qnty/Cum	Rs. 1,05,000 excluding HT Strands Rate analysis as per KPWD / Railways / CPWD SOR	Rs 34835 As per KPWD SR		
12		Amount in Cr		Savings in cost by adopting UHPFRC Technology	Savings in %
		UHPFRC Technology	PSC Conventional Technology		
13	Pre- construction Activities, Site Clearance & Dismantling	3.41	3.41	0.00	0%
14	Foundation (Pile &Pile cap)	199.40	240.32	40.93	17%
15	Sub Structures (Pier & PSC Pier cap)	45.56	72.33	26.77	37%
16	Super Structures (UHPFRC - U Girder)	488.66	888.99	400.33	42%
17	Reinforced Earth Approach ramps to super structures (RE Wall)	3.38	3.38	0.00	0%
18	Wearing Coarse for super structures (SMA)	7.95	7.95	0.00	0%
19	Finishing items for super structures (Crash Barrier, painting, Handrail etc.)	17.29	36.16	18.87	51%
20	Streetlight over flyover	4.68	4.68	0.00	0%
21	Noise Barrier for controlling noise on flyover	1.32	1.32	0.00	0%
22	Reconstruction of White topping road at approaches	18.83	18.83	0.00	0%
23	Restoration of existing road after completion of flyover construction and Rainwater Harvesting	25.28	27.57	2.29	8%
24	Re construction of Compound wall at LA Location for Government and private properties	1.05	1.05	0.00	0%

Sl. No.	Description	UHPFRC Girder	HSC Box Girder	Savings wrt HSC Technology in terms of Number	Remarks Savings in %
25	Credit for Dismantled Material: Deduct Salvage values from Dismantled structures like SSM masonry (scarp material Steel 151.55 MT (from Existing ROB structures, RE Wall) RE earth from Dismantled Existing RE wall structures 60% of existing earth is considered for reuse during new RE wall structures.	-0.01	-0.01	0.00	0%
26	Design charges @ 0.57% on total of above items 2 to 9 as per SR V-1 Sl. No. 1 Page 117 as it is EPC contract	4.63	6.28	1.65	37%
27	Maintenance charges for stand-alone projects like Bridge/ Tunnel /flyover works: the contractor shall be paid @ 0.25% of the Contract Price each for the first five years and @ 0.50% of the Contract Price each for the remaining period of five years. on total of items as per MORTH Ltr No.RW/NH-37010/4/2010-EAP(Printing) Vol.-IV Government of India Ministry of Road Transport & Highways Dated: 05.03.2019 AT Model agreement page 76 under section 14.1 d	30.55	9.84	3.51	36%
28	**Amount Put to Tender (Civil Construction Cost)**	**852.00**	**1322.11**	470.11	36%
29	GST @ 18% on Amount Put to Tender	153.36	237.980	23	10%
30	Provision for Contingencies and Provision for Departmental Establishment Charges @ 2% on APT.	16.18	26.44	10.26	36%
31	Provision for Independent Engineer / PMC/DPR @ 1.50% on APT	12.78	19.83	7.06	36%
32	Provision for Price escalation @ 2.5% for the 2nd year i.e., 2.5% on APT	21.30	33.05	11.77	36%
33	Provision for utility shifting @ 8% on APT	68.16	105.77	37.68	36%
34	Provision for Arboriculture/ Afforestation @ 0.50% on APT	4.26	6.61	2.35	36%
35	Land Acquisition Cost including Structures	171.39	171.39	0.00	0%
36	Miscellaneous and other Department Deposits	0.56	0.83	0.00	0%
37	**Total Project Cost**	1300.00	1924.02	624.02	32%

Sl. No.	Description	UHPFRC Girder	HSC Box Girde	Savings wrt HSC Technology in terms of Number	Remarks Savings in %
38	Estimated cost : Interms of Structural area in Sqmt Area and in terms of Km wise	UHPFRC		HSC Girder	
39	Cost/Sqmt (Structurer Area 72156.4.40 sqmt) for structure alone (considering Foundation + sub + super structure + RE Wall approaches + Finishing + Lighting + Wearing course) = Rs.70478/sqmt for UHPFRC & Rs 1,11,958/Sqmt for HSC Type concrete.	On Amount Put to Tender	On Total Project Cost	On Amount Put to Tender	On Total Project Cost
40	Cost/Sqmt Sl No 28 / Sl No-3	72840	111252	113144	164654
41	Cost/Km Viaduct length 12469 + Approach 0.580 km Total Length = 13.049 km	65	100	101	147

Table 3-3 Cost comparison between using UHPFRC Girders and HSC Box girders

3.6 Design Standards

3.6.1 Planning of Geometry and Structural Design Standards

Planning criteria for elevated flyovers, as outlined by the Indian Road Congress (IRC), include considerations for traffic analysis, design speed, road width, and vertical clearance. These criteria ensure safe and efficient traffic flow and adhere to standards for urban areas.

3.6.2 Geometry

The objective of geometric design is to provide maximum efficiency in traffic operations and maximum safety at reasonable cost. The horizontal geometry shall be designed in accordance with IRC 86 - 1983.However, the Geometry in urban areas mainly depends on site conditions like modifying geometry of alignment at existing structure, to maintain existing road profile, restriction of width due to building lines etc.,

3.6.3 Carriageway Width

i. The carriageway width for four lane shall be provided as per the provisions of IRC Codes for the traffic requirements as determined by traffic census and studies.

ii. The carriageway width on the elevated structure shall be kept same as on the approaching roads on both side and the widths shall not be reduced abruptly under any circumstances.

3.6.4 Design Speed

Design speed is related to the function of a road. Keeping in view the type of road considering for the project road as sub arterial/collector Street as per the urban road with mixed traffic system, the design speeds of 40kmph is adopted.

3.6.5 Horizontal Curves

Horizontal curves should consist of a circular portion flanked by spiral transitions at both end. Design speed, super-elevation and coefficient of side friction affect the design of circular curves. Length of transition curves is determined on the basis of rate of change of centrifugal acceleration and super-elevation. Horizontal curves, are designed in accordance with I RC: 38 1988.

3.6.6 Widening at Curves

Wherever horizontal curves are provided in Grade separators, the carriageway is widened as per relevant codes. The structures having entry and exit ramps are provided with adequate length of acceleration/deceleration/merging lanes to ensure free and safe flow of traffic and to avoid congestion near the mouth of such ramps resulting in traffic jams.

3.6.7 Sight Distance

Adequate stopping sight distance shall be provided at all points on the road in conformity with IRC standards for 40Kmph 60m Sight distance is proposed:

3.6.8 Clearances at Elevated Structures

The minimum horizontal clearance shall be the clear width and the minimum vertical clearance the clear height available for the passage of traffic. The minimum vertical clearance of any structure provided over the project road shall be 5.0 m for non-urban areas and 5.5 m in case of urban areas. In case of structures over local or collector streets, where only light commercial vehicles are plying and where alternative routes for heavy commercial vehicles and fire tenders are available within a short distance, this may relax the clearance requirements of 5.5m. At locations where over-dimensional vehicles are frequently plying, will consider providing increased vertical clearance. The minimum horizontal and vertical clearances for single and multiple lane bridges with vehicular traffic shall be followed as per the provisions of IRC: 5.

3.6.9 Super-elevation

Super-elevation shall be provided on a horizontal curvature in accordance with the relevant IRC Codes.

The effect of super elevation on stresses in the various members of the structure shall be taken into account in the design Super-elevation shall be limited to 7 percent. However, as the project road is in urban sections with frequent intersections, it may be limited to 4 percent.

3.6.10 Gradient and Profile

The Gradients in the approaching viaducts or earth embankments shall usually be limited to as per the relevant provisions of IRC codes 92-1985. However, in situations where sufficient space or length is not available then the gradients may be locally increased to meet the requirement after judiciously considering the type of traffic using the facility. For vertical gradient for ramps will be limited to 4% as per site condition and will not be exceed 6%.

3.6.11 Drainage

Effective drainage shall be ensured by providing drainage spouts connected with horizontal and vertical pipe system such that the water from the structure does not fall on the roads, does not stagnate over the roads or at entry and exit points of the grade separators and is discharged into the overall draining system devised for the project area.

3.6.12 Camber

Camber shall be provided as per relevant IRC codes. Camber on grade separator with high type bituminous surfacing or cement concrete surfacing should be 1 .7 to 2 .5 percent. The camber of 2.5% is proposed in deck and approaches.

3.6.13 Railings, Parapet or Crash Barriers

Railings or parapets shall be provided on both sides of the bridge for the protection of traffic. Apart from its structural strength considerations shall be given primarily to the architectural features of the railing or parapet to obtain proper proportioning of its various elements to harmonies with the structure as a whole. Consideration shall also be given to avoid, as far as is possible obstruction of the view from the passing motor cars.

Crash barriers shall be provided for grade separators designed for high speed vehicles particularly project roads in urban areas. Crash barrier of concrete is provided.

3.7 Design Standards of Structures.

Design of Elevated Corridor shall be carried out as per relevant IRC standards.

3.7.1 Materials of Construction & Specifications

The material for the grade separators is generally concrete.

One of the considerations in selecting the concrete material is that construction should be possible without causing too much inconvenience to the existing traffic for a long time. Use of Ultra High performance of Fiber reinforced Concrete of M150 to M 200 is proposed to make the structure look slim and more durable.

3.7.2 Loads

Loading standards shall be in accordance with IRC: 6. for grade separators of 2 lanes and above, live load categories as defined in IRC: 6 is adopted.

3.7.2.1 Bumper to Bumper Traffic

In crowded towns, vehicles have to stop at traffic signals or on account of traffic jams. In such cases vehicles may be standing bumper to bumper on grade separators. The effect of this loading should also be considered in the design. Proposed to design as per IRC-Class A vehicle.

The crash barriers of concrete is proposed to be provided for grade separators designed for use by high speed vehicles in urban areas just after the ends of carriageway. The loading and design criteria for crash barriers shall be as per 1RC; 6.

The foundations shall be designed to withstand the worst combination of loads and forces evaluated in accordance with the provisions of Clauses 700 and 707 of IRC: 78. The foundations shall be taken to such depths that they are sufficient from consideration of bearing capacity, settlement, stability and suitability of strata at the founding level and sufficient depth below it.

The part of the grade separators falling in line of traffic will be designed for collision loads and impact as per IRC:78

3.7.3 Minimum Dimensions

The minimum dimensions of various members or components shall follow the provisions of relevant IRC Codes.Using the new technology of UHPFRC, the thickness of the structural components based on IRC loading depends on the actual design and is certified by the authority before implementation.

3.7.4 Design for Continuity

The continuity of the superstructure is achieved by providing full continuity or continuity for live load only. This is achieved by providing superstructure longitudinally continuous over intermediate supports on bearings.

Segmental box girder bridges are typically designed with a U shaped box- cross-section, often using prestressed concrete, steel/steel fiber, or a combination of both. Geometric design considerations include span lengths, box dimensions (width, depth, and length of segments), and the arrangement of cells within the box. Structural design focuses on ensuring the bridge's stability, durability, and ability to withstand loads, considering factors like span-to-depth ratios, material properties, and connection details.

The detail and the design proposal followed for this project of elevated corridor is summarized in the Table 3-4below.

Sl. No.	Details	Description
1	Proposal of carriageway	Four lane divided carriageway
2	Overall Width of bidirectional Carriageway	Proposed width is 8.5/12/17.2m
3	Overall width of unidirectional Carriageway	Proposed width is 8.5 m
4	Width of RE wall approaches for unidirectional Carriageway	Proposed width at up ramp for RE Wall approach is 6.5 m for a shorter length of 100m is proposed as per site condition to avoid the acquisition of existing multistoried buildings
5	Length of Project road as per GO	10.0km
6	Length of Existing Flyover constructed by M/s Simplex at Ejipura	2286
7	Actual length of Elevated Corridor to be proposed in the Project Road	13.049Km
8	Type of Structure	Elevated Corridor as flyover with RCC Structures
9	Intermediate Span of elevated corridor	Longer Span of 45m at straight stretch and 35 m ar curve and cantilever portion is proposed
10	Type of Foundation	RCC Pile foundation with Bored Cast in situ piles as per IRC
11	Type of substructure	Circular pier with pile cap structure. Circular pier diameter of 2.0m/1.6m. PSC Pier cap of 3.2m/6.0m/8.0m length at the top of pier for 8.5m/12.0m/17.2m width of elevated structure.
12	Type of Bearing	POT Cum PTFE/ Elastomeric Bearing
13	Type of Girder with deck slab	Precast segmental UHPFRC U type box girder with open cross-section with Post tension.
14	Segmental Construction	A typical segmental box girder is designed with a length of approximately 5.0 m and a depth of 2.2 m, excluding the deck slab thickness of 250 mm. The cross slope is generally provided at 2.5% to facilitate surface drainage.
15	Launching methodology	**1. Span-by-Span Method** Each segment is placed sequentially and stressed span by span, ensuring controlled alignment and stability during construction. **2. Pre-Assembly and Lifting Method** After all segmental girders are assembled and stressed on the ground, a 150–200 MT capacity crane can lift a single girder unit and place it directly on the pier cap
16	Type of Pier cap	Pre cast pier cap of High strength concrete

Sl. No.	Details	Description
17	Load consideration	
18	Permanent Loads (Dead Loads):	Self-weight of the structure: The weight of the box girder and deck slab
		Superimposed Dead Loads (SIDL): Loads from components like railings, barriers, medians, and wearing courses.
19	Live Loads (Traffic):	Vehicular Live Loads: Loads from traffic moving on flyover, including both normal and crosswise loading. IRC (Indian Road Congress) IRC: 70R & Category AA: Specific live load categories used in Indian standards.
20	Type of other loads considered for design	Temperature Loads: Post-Tensioning Loads: Construction Loads:
21	Load Combinations: The design will consider various load combinations, including DL, SIDL, post-tensioning, and live load, to ensure the structure can safely withstand all anticipated loads.	DL (Dead Load): The weight of the structure itself. SIDL (Superimposed Dead Load): Loads from elements like railings and barriers. Secondary Pre-stressing parameter: Loads related to the post-tensioning system. LL (Live Load): Loads from traffic.
22	Grade of Concrete for Box girder	UHPFRC M-150-200 Concrete
23	Grade of Concrete for Pier cap & Pier	M 35
24	Grade of Concrete for Pile and Pile cap	M-35 Concrete
25	Grade of Prestress strands	Low -relaxation strands: These strands are chosen for their ability to maintain a stable level of pre stress over time, minimizing relaxation (loss of stress) due to creep and other effects.
26	Type/Grade of Reinforcement	Copper coated Steel Fiber for girders /Fe 500 for foundation/substructures/deck slab
27	Various types of Permissible stress	For segmental box girders, permissible stresses as per applicable country/IRC codes, specifically IRC SP 65-2005 and IRC 112-2011, are primarily focused on ensuring structural integrity and safety during various stages, including construction, handling, and service life.
28	Wearing Coat	The wearing coat shall be provided over the deck to resist traffic wear and to provide a smooth riding surface. The type of the wearing coat is Stone Matrix Asphalt. Before laying Wearing coat, Waterproofing of deck slab shall be carried out using 3 mm thick APP polymer-modified bituminous membrane reinforced with polyester, torch-applied over a primed concrete surface, conforming to IRC/MoRTH specifications.

Table 3-4 Showing Design Proposal

3.8 Approaches to Elevated structures in Urban Locations

The project road is in urban areas sufficient width is not available and wider roads & drains are required on all sides. Earthen banks also require considerable quantity of earth which has to be brought from long distance & the cost is also more. Considerable costly land is occupied by the approaches. Solid earthen embankments also obstruct the view and do not look good.

As such earthen approaches are not considered in this project road. Viaduct spans up to a height of 5.0 m is extended so that in the last span a vertical clearance of 3 to 3.5 m is available. This may be followed by retained embankment either by retaining walls or reinforced earth walls.

3.8.1 Retaining Walls and Return Walls

Reinforced Soil Structures is proposed as Retaining wall and to protect the earth at the last span of viaduct to retain the earth.

i. Reinforced earth retaining walls constructed with soil backfill reinforced with inextensible flexible reinforcement, such as metallic strips or sheets or extensible geo synthetic materials, such as; geo-textiles and geo-grid, are used for solid ramp portion for approaches of flyovers, grade separators and or embankment. It does not cover load bearing abutments.

ii. Selected fill and filler material conforming to specifications given in relevant IRC standards are used in the reinforced soil structure as back fill behind fascia panels. The material is granular and purely non-cohesive.

iii. Geo-synthetic material may be woven, non-woven or knitted sheet used in geo-technical engineering and other civil engineering applications that sustain design loads at permissible strains and defined creep characteristic with maximum elongation less than the permissible limit.

iv. Metallic reinforcement is in the form of strip or rod or square welded mesh/ net which sustains load at strains less than or equal to the permissible value.

v. The facia panels should be cast with proper line and finish preferably in a casting yard. They can be given different treatment with patterns to suit the aesthetical requirements or giving any effect.

vi. The back fill material should be properly compacted in the designed thickness of layers, as per the specifications.

vii. The facia panels should be erected to give uniform surfaces and fixed to the reinforcing materials such that these are not dislodged.

viii. The drainage layer of prescribed specifications should be provided as required by design and specifications and it should be ensured that it will remain functional and will not be choked because of flow of silt particles in the backfill, during the outflow of water, as it may result in the failure of embankment.

4 Design report with Improvement Proposals.

4.1 Elevated Corridor and approaches.

Considering the present and feature growth of traffic volume and movement pattern to reduce the traffic congestion between the Old madras road and towards Silk board through Indiranagara, Domlur and Koramangala via Madivala an elevated corridor of four lane bidirectional flyover is proposed.

4.1.1 Proposal from Starts to End of Project road

The project road is very close to Swamy Vivekananda Metro Station on Old Madras Road NH-7 near Benaganahalli metro depot. The chainage 0.00 starts from Swamy Vivekananda Metro station junction (proposed elevated rotary/ 3 legged intersection) on Old Madras road NH7 from K R Puram. This road leads to Silk board junction via Indiranagaraand Madivala. The total length of Project Road including Existing flyover at Ejipuraup to Silk board junction is 11.625km as per concept plan prepared with marking of chainages. Description of the start and end of the elevated structure is described in the table below.

SI. No.	Description	Chainage		Length in Km	Width in m
		From	To		
1	Indiranagara from Rotary along 80feet road via 100ft road Length of Approach=100m ,Length of Viaduct = 2825m	0+100	2+925	2.825	12.00
2	Down ramp to Indiranagara at Rotary junction near C V Raman General Hospital Length of Approach=100m ,Length of Viaduct = 110m	0+100	0+310	0.210	7.00
3	Down ramp to Old madras road at Rotary junction near C V Raman General Hospital Length of Approach=100m, Length of Viaduct=150m	0+107	0+357	0.250	5.50
4	from chainage 2+575 to 3+587 to cross existing Domlur interchange including taper length of 150m &2 m additional length due to double level Length of Approach = 100m, Length of Viaduct = 914m	2+575	3+587	1.014	7.00
5	up ramp from Sarjapura Approach including tapering of 150m Length of Approach = 100m, Length of Viaduct = 240m	0+000	0+190	0.340	7.00
6	Ejipura to Madiwala rotary (LHS+RHS) 360.5X2=721m Length of Viaduct = 721m	8+368	8+728	0.721	8.50
7	Proposed Audgodi loop INCLUDING 7 M & 17.2 M Carriageway (LHS+RHS) + TAPERING 2 X 120M Length of Viaduct = 960m & 202m	0+000	0+360	0.960	7.00
		0+360	0+562	0.202	17.2
8	Audgodi loop to Silk board continued Length of Viaduct = 120m	0+562	0+682	0.120	7.00
9	Tunnel approach connecting to Audgodi loop170m with tapering length of 120m Length of Approach = 80m, Length of Viaduct = 210m	290m		0.290	7.00

SI. No.	Description	Chainage		Length in Km	Width in m
		From	To		
10	Double deckar flyover from Banashakari to Madiwala junction including taper length of 120m+30m of joint connecting at ch 270 Length of Viaduct = 634m	634m		0.634	7.00
11	From Rotary to Hosur crossing Double deck flyover towards Hosur , HSR Layout 200m and Hosur to Madiwala side	8+782	9+766	2.011	7.00
12	8+782.5 to 8873 (LHS) 90m+RHS 878.25 towards Masjid -90m Length of Viaduct = 180m	2078m		0.180	7.00
	8+873 TO 9191 Length of Viaduct = 318m			0.318	7.00
	Double level from 9+766 TO 9191 (LHS+RHS)= 575 X 2+ add 2m for additional length due to double level Length of Viaduct = 1152m			1.152	7.00
	from ch 9561 -Towards HSR road loop 200m + taper length of 150m Length of Viaduct = 350m			0.350	7.00
13	Rotary at Madiwala junction Length of Viaduct = 157m	157m		0.157	15.00
14	Flyover from Silk Board to Electronic city flyover Ch 9820 to 10975+ taper length on either side with 120m Length of Viaduct = 1395m	9+820	10+975	1.392	8.50
15	Electronic city to Banashankari double deckar Ch 0.00 to 1591+tapering of 120m length at start and end	0+000	1+591	1.831	8.50
	Total length of Elevated Corridor			**13.049 Km**	
	Total length of Approach			**580.00m**	
	Total Length of Viaduct			**12469.00m**	
	Total area of Viaduct			**102691.0Sqm**	
	Total Area of Approach			**4410.0Sqm**	

4.1.2 Features of Elevated Corridor

Number of Lane : 2/3/4 Lanes

Minimum Carriageway Width : 2/3/4 x 3.5 m

Crash Barrier : 2 x 0.5m

Total width of Structure : 8.5m/12.0m/17.2m

Merging/Diverging Taper lane : 200m

Minimum Vertical Clearance : 5.5m (Varies as per site condition)

Minimum Radius of Curve : 70m

Viaduct Span for straight reach : 45m

Viaduct Span at Curve location : 35m

Viaduct span for 8.5m Carriage Way : 45mwith cantilever pier cap

Vertical clearance for second level structure : 5.5m

Supporting structure at split section / wider : Portal frame with UHPFRC I Girder as beam

Type of Box Girder : Segmental UHPFRC U Girder

Foundation : Deep Pile foundation

Type of Box Girder : Segmental UHPFRC U Girder

Entry / Exit Ramp : with RE Wall approach

4.2 At Grade Road improvement

The 4.430 km long at-grade road starts from the metro station on Old Madras Road to Domlur Junction is constructed within white topping and the buffer zone between the edge of the CC road and the sidewalk is paved with cement concrete pavers. The center of the road is bisected with a centerline of 0.5 m median.

When an elevated structure is started for construction, the central section of 3 meters width is continuously barricaded and utilized for the construction of foundation and substructure works within the site. An additional 2 meters of space will be used in addition to the 3 meters at each pier location. During construction, at some places, the CC road and pavers laid in the buffer space between the CC road and the sidewalk in the middle will be damaged.

The restoration of White thin topping and reconstruction of CC pavers along with foot path pavers is included in the estimate. Apart from this reconstruction of road on approaches Hosur Road near St. Jhon property and on Sarjapura Road in the premises Survey of India office. Further the entire flexible area of the pavement along the corridor from Old Madras Road to Begur Road junction of 11.625Km is proposed for overlay of 40mm Bituminous Concrete (BC) and 60mm of Dense Bituminous Concrete (DBM) used for profile correction to correct the undulations including desilting of the existing drain with repairs at damaged locations.

4.3 Proposed for Land Acquisition

The area of acquisition of private land and property of Government entities required for acquisition is listed in Table 4-1below:

Part No.	Chainage in m		Location / Road	Type of Land	Area in Sqmt	Area in Acres	Type	Area in Sqmt
	From	To						
1	0.00	350.00	Indiranagar 80 Feet Road	Government (Sir C.V.Raman General Hospital)	2825.93	0.69	-	-
2	107.00	140.00	Indiranagar 80 Feet Road	Private (St. Michals Home Convent)	55.30	0.01	-	-
3	140.00	240.00	Indiranagar 80 Feet Road	Private	696.81	0.17	-	-
4	240.00	255.00	Indiranagar 80 Feet Road	Private	104.81	0.02	-	-
5	255.00	235.00	Indiranagar 80 Feet Road	Private	516.13	0.12	-	-

Part No.	Chainage in m		Location / Road	Type of Land	Area in Sqmt	Area in Acres	Type	Area in Sqmt
	From	To						
6	235.00	370.00	Indiranagar 80 Feet Road	Private	52.06	0.01	-	-
7	678.00	690.50	Indiranagar 80 Feet Road	Private	6.07	0.001	-	-
8	690.50	720.00	Indiranagar 80 Feet Road	Private	50.31	0.01	-	-
9	760.50	840.50	Indiranagar 80 Feet Road	Private	408.40	0.10	-	-
10	1360.50	1460.50	Chinmaya Mission Hospital Road	Government (CMH Park)	363.80	0.08	-	-
11	3428.00	3496.00	Inner Ring Road	Private (Golf View Apartment Natasha)	310.38	0.07	-	-
12	3496.00	3640.00	Inner Ring Road	Government (Department of Space (ISRO) Housing Colony)	788.79	0.19	G+4	7.85
							G+4	172.55
13	3640.00	3668.00	Inner Ring Road	Private	123.78	0.03	G+3	447.16
14	0.00	190.00	Inner Ring Road	Government (Survey of India)	2858.08	0.70	Sheet	658.44
							RCC	125.41
15	8368.50	8728.00	18th Main Road & Hosur Road	Private (St. John Medical College)	7820.87	1.93	-	-
16	125.00	162.00	Hosur Road	Private	126.58	0.03	Sheet	106.72
17	8706.00	8840.00	Hosur Road	Private	1808.5	0.44	G+1	124.04
							BS+G+2	747.60
							BS+G+3	2136.95
							BS+G+1	519.81
							G+1	251.52
							G+1	71.78
							G+1	189.02
							BS+G+2	636.84
							G+2	126.48
							G+2	66.54
18	0.00	473.00	Banshankari Road to Hosur Road	Private	4385.85	0.97	G+3	0.16
							G+1	3.32
				Total	**23302.45**	**5.57**	**18Nos**	**6392.19**

Table 4-1 List of Land acquisition

ABSTRACT			
Sl. No.	**Type of Land**	**Area in Sqmt**	**Area in Acres**
1	Private Land	16465.85	3.91
2	Government Land	6836.6	1.66
	Total	23302.45	5.57

Note: **1. Structures (Government + Private) :** An area of 6392.19 sqmt is considered for reconstruction of assets in the Government Land and Private Land at the rate of Rs.30920.00/sqmt under the category of office/ colleges as per CPWD Plinth Area Rates of 2025 which is worked out for Rs.19,76,46,514.8/-

2. Land Acquisition Area :

Land Value as per Registration and Stamp No. CVC/99/2023-24, Bengaluru, Dated: 27-09-2023					
Sl. No.	**Location**	**Private Land Area in Sqmt**	**Guideline Value Page No & Sl.No**	**Rate as per Guideline Value**	**Total Amount in Rs.**
1	Indiranagar (CMH Road & 100feet Road)	1889.89	Page 36, Sl no.10	150000.00	283483500.00
2	Indiranagar 100ft Road & Domlur	434.16	Page 40, Sl no.74	270000.00	117223200.00
3	Koramangala (Sarjapura Road, Madiwala & Hosur Road)	6320.93	Page 143, Sl no.291	160000.00	1011348800.00
	Total	**8644.98**		**Total**	**1412055500.00**

An amount of Rs.1,41,20,55,500/- is reserved for Compensation of land of area 8644.98sqmt arrived based on guideline value (Registration and Stamp No. CVC/99/2023-24, Bengaluru, Dated: 27-09-2023) as Shown in the above table.

Out of the total land acquisition area of 23302.45Sqmt Majority of the private land i.e. 7,820.86 Sqmt belongs to The Director, St. Johns Medical College & Hospital Secretory, CBCI Society which is proposed for Land Acquisition under North-South Tunnel project. Hence Area required for Acquisition in St. Johns Medical College & Hospital Property is excluded further Private Land of 8644.98sqmt is required for construction of Elevated Corridor from Old Madras Road to Silk board rest of the property of 6836.6sqmt proposed for acquisition belongs to Government. thus an amount of Rs.1,41,20,55,500/- is reserved for compensation of land arrived based on guideline value (Registration and Stamp No. CVC/99/2023-24, Bengaluru, Dated: 27-09-2023 and Reconstruction of affected Structures of an area of 6392.19 sqmt. Which is worked out for Rs.19,76,46,514.8/- further escalation Amount of Rs.10,41,65,940.05/- is considered for Land and Structures. Hence the Total Amount of Rs.1,71,38,67,954.85/- (19,76,46,514.8 + 1,41,20,55,500 + 10,41,65,940.05) is reserved for Land Acquisition including Structural Compensation.

4.4 Structural type Proposed for Elevated Corridor

Various structural arrangement options were studied for the proposed flyover based on:

- Functional requirement.

- Characteristics of subsoil.
- Facilities to be provided at grade.
- Ease in construction.
- Economy etc.
- Topography of Site condition.

Accordingly, the structural system was planned taking into account suitability of the same at the proposed location, constructability, level of impact on traffic movement during construction etc. Elevated Corridor is planned based on subsoil report.

4.4.1 Superstructure of Elevated Corridor

The type of material proposed for the superstructure is UHPFRC PSC open U box girder.

The relative thicknesses of the web, top, and bottom flanges are determined through a design process that considers factors like span, loading, and relevant design codes, as outlined by the code of applicable countries and Indian Road Congress (IRC).

An open box U girder as a supporting structure for flyover is primarily proposed to efficiently carry loads over long spans, especially in horizontal curves or situations where a shallow section is needed. The main purpose is to maximize structural efficiency by minimizing weight while maximizing flexural stiffness and load-carrying capacity, making it suitable for flyover applications.

In this Segmental U box girders, the thickness of the web, and bottom flanges is not a fixed ratio but rather a design decision based on the specific bridge's span, loading conditions, and other factors.

Web Thickness: The web thickness of the box girder is provided with 200mm for span length of 45m.

Bottom Flange Thickness: Minimum thickness: 1/20th of the clear web spacing at the junction with the bottom flange, or 200mm, whichever is more. Purpose is to resist tensile forces and provide additional torsional stiffness. Proposed bottom flange is designed for 250mm.

4.4.2 Substructure

4.4.2.1 Pier Cap

Cast-insitu/Precast Pier Cap is designed to be fixed as an integral part with the pier with solid concrete unit. The pier cap length is designed to accommodate the box girders. The length of pier cap is 6m for 17.2m Carriage way which can accommodate the Sturted box girders.

The height of the pier with bottom of pier cap is based on the clearance requirement. Where vehicles have to cross below, minimum required vertical clearance of 5.5 m is ensured. At other support locations, the pier height varies according to the road profile.

4.4.2.2 Pier

The proposed substructure is a circular pier. The circular pier provides good structural integrity and resistance to impact, while the pier cap distributes loads from the bridge deck or superstructure to the pier, ensuring a stable and even distribution of forces.

Circular piers are often chosen for their strength and ability to resist both axial loads (from the bridge deck) and lateral loads (from wind, seismic activity, or vehicle impacts). Their rounded shape allows for a more even distribution of stress compared to rectangular or square piers, especially under off-center impacts. A single pier is proposed for the four lane superstructure. A circular pier with 2m is proposed.

4.4.3 Foundation

The foundation type depends on the subsoil nature and condition at the location. Bore holes taken at site were studied to get a fair idea of the subsoil composition and to decide on the suitable founding levels. Various tests conducted at the field and laboratories were reviewed to assess the subsoil composition and nature. The Soil strata at the location of construction of Elevated Corridor is very hard and stiff with Non-cohesive soil. As could be seen from the borehole drawings based on geotechnical investigation report, the hard strata could be seen below the ground at a depth of 25-30 m with N- value greater than 100.

Based on the test results, it is proposed that the foundation of the structure has to be taken deep with the purpose of attaining a bearing strata which is suitable and which ensures strictly and durability of structure.

Pile foundation of 1.2m dia is proposed with a pile group of 6Nos, the spacing and width of the pile cap is proposed as per IRC standards.

4.4.4 Elevated Rotary Structure

Madiwala Junction a T junction at Chainage: 8+782 with Underpass which is on Hosur Main Road is connecting mainly from Sarjapura/Ejipura Road with Hosur Road from St. John junction to Silk Board Junction after studying various structural options for designing this junction with all possible views to meet this junction and IRC standards. The following options of structures were studied. The type of structure is chosen based on their advantages and disadvantages.

a. Elevated Rotary
b. Clover leaf
c. Underpass

Elevated Rotary: The elevated rotary concept was chosen based on the advantages of its circular type, which enables access from all directions without traffic conflict. Other advantages are that it can be accommodated on available land. High speed operations of heavy traffic movement at this junction can be handled with low speed due to short weave distance. This type of structure is a significant advantage as there is slow traffic.

Clover Leaf: Options for the Clover Leaf Interchange were tried by designing one loop ramp for right-turning traffic and one outer connection for left-turning traffic in each quadrant. These types of structures require more than one structure of different levels and providing approaches is a big problem. The land acquisition area required to be more for providing service roads along the approaches.

At the planning stage it was found that this type of structure would not suit the proposed and existing railway lines. Also turns out to be very expensive.

Underpass: The scheme of underpass at this junction is inconvenient since already and underpass is constructed at the center of road and extending underpass further was not feasible and completely blocked due to direct access without provision of left or right turns. Proper drainage system is also becoming a problem.

After analyzing the above options in consultation with department, it was finally decided to plan to provide an elevated rotary concept to ease the traffic to overcome the land issue constraint and meet the requirements.

Rotary Concept

The concept of selecting the junction type at this location is as follows

1. Vehicles entering the rotary are forced to slow down and continue moving slower speeds prevent vehicles from stopping at intersections.
2. Traffic flow is regulated in one direction of movement only, thus eliminating severe collisions between crossing motions.
3. This is ideally suited for medium or high traffic or at intersections with at least three or four approaches.
4. Rotaries are self-governing and practically require no control by police or traffic signals.
5. Due to reduction in speed of vehicles, severe conflicts and accidents are avoided and their intensity is less in rotaries.

4.4.5 Geometric and Structural Design Standards

The geometry of Madiwala junction includes open land in the middle having a circular shape and road development on all three sides, north-south and east-west. At present, this junction has a main entrance to connect the north-south dual carriageway.

As per the site situation and ground reality, an attempt has been made to design the junction in an innovative way by raising a circular structure in the Centre in a rotary form to utilize the available land. Allow access to connect the road in all directions conflict-free by allowing the junctions to accommodate additional lanes required as they are planned for future lanes. To accommodate the heavy traffic of around 2250veh/hr and 2510veh/hr, there is a need to channelize the traffic in the limited land with innovative design of elevated rotary as grade separator.

Traffic rotary or roundabout is a special form of at-grade intersection in which one-way traffic flows around a large center island before weaving into the respective directions from the traffic flow emanating from the center island. In our country, the 'keep left' regulation is followed and the flow around the central island is clockwise.

In a rotary intersection there is a smooth and efficient flow of traffic. All traffic proceeds at a fairly uniform speed. Frequent stopping and starting of vehicles are avoided. Crossing movements are converted into weaving or merging and diverging operations. Direct conflict is eliminated. Thus the journey is more consistent and comfortable.

The design of rotary elements requires special considerations depending on each site requirement. No standard design can be adapted to any particular site conditions. So it became necessary to design the intersection and increase the capacity of the road smooth and safe traffic movement.

As this project road falls within urban limits, relevant IRC design standards are due consideration to the Latest directives and guidelines of MORT&H/IRC have been followed as far as possible while formulating design criteria. Other national and international standards are also cited where found relevant. The criteria for various components are explained below.

4.4.6 Geometric Standards

IRC: 86 – 1983, "Geometric Design Standards for Urban Roads in Plains".

IRC: 92-1985, "Guidelines for the design of interchanges in Urban areas"

4.4.7 Design Speed

The proposal at the junction is an elevated rotary. Therefore, the design speed of the rotary is less than that of the roads leading to it. Although it is possible to design a Rotary without reducing high speed, the geometry can cause large costs for large-scale construction. The normal design speed considered as 30 to 35 kmph for urban areas.

4.4.8 Carriageway Width.

As per The traffic demand on the project road a 4-lane flyover is justified from the point of view of traffic capacity.

Up/down ramps shall be established to ensure smooth access which induces efficient circulation of expected traffic in all directions.

The maximum grade of approach road is set below max 5% to ensure climbing performance on slippery surfaces and to reduce accidents on steep slopes in winter and reduce vehicle traction, as evidenced by the results of site surveys on several road sections along steep gradient.

Based on the traffic demand as per the projections, four lane configurations are proposed for rotary flyover. An intermediate carriageway of minimum width is proposed for service roads with footpath cum drain of 2 m.

4.4.9 Camber.

A camber of 2.5% is proposed for rotary flyover and carriageway of service roads.

4.4.10 Super Elevation.

Super elevation of rotary roads is ignored. But, here if the vehicle changes its direction to its opposite side it travels around the Central Island and changes direction. While shifting, the vehicle may turn or slip, to overcome this, a minimum lateral slope is provided which is nothing but camber. In rotary roads this camber acts as super elevation.

4.4.11 Horizontal Geometry.

A design speed of 35 kmph is proposed at the rotary flyover and Graded roads. Rotary design is based on the traffic operations of diverging, merging and weaving. The design elements include design speed, radius at entry, exit and the central island, weaving length and width, entry and exit widths are designed as per IRC-65. The Radius of Rotary is designed with minimum radius of 1.3 times of entry curve. The entry to the rotary is not in straight, but a small curvature of about 20 and 25 meters is introduced. The exit radius provided is 1.5 to 2 times than the entry radius of the rotary so that the vehicles will discharge from the rotary at a higher rate. The width of the weaving section is kept higher than the width at entry and exit preferably between 6 to 18m and weaving length available at the intersection is between 18 to 25m. The traffic rotary is designed as per standards and is reducing the complexity of crossing traffic by forcing them into weaving operations.

4.4.12 Elevated Rotary and approaches.

Considering the high traffic volume and complex movement patterns at this T-junction, an elevated rotary with a four-lane unidirectional flyover is proposed to reduce congestion. The junction lies in close proximity to both St. John's Junction and Silk Board Junction, making it a critical node in the network.

1. Design Concept

a. The rotary flyover is designed to allow vehicles to move continuously without stopping.
b. While vehicles do not halt, they may change direction or cross paths at reduced speeds.
c. Standard city road speeds are not applicable at rotary intersections; traffic must pass at low, controlled speeds to ensure safety and minimize collision risks.
d. Speed control panels will be installed at approaches to regulate movement through the rotary.

2. Structural Features

a. The rotary flyover will consist of fully curved sections along all approach arms, with only short straight lengths near the ends of the approaches.
b. Soil slopes with earth-retaining structures are proposed beyond the abutments on all approach sides to ensure stability.
c. A minimum vertical clearance of 5.50 m from the existing road level will be maintained at obligatory span locations, ensuring adequate passage for vehicles and compliance with standards.

Improvement proposals of Rotary

Elevated Rotary and its geometric standards, lane width and median are designed as per IRC norms, Rotary Carriageway is four lane width of 14.0m each lane 3.5m wide with 0.5m RCC crash barriers provided on edge of rotary the total width of Rotary is 15.0m. The main features are shown below.

Features of Elevated Rotary at Madiwala T Junction

Proposed Location	: Madiwala T Junction at Chainage: 8+782
Number of Lane	: 4 lanes unidirectional
Total width of Elevated Rotary	: 15.0m
Minimum Carriageway Width	: 4 x 3.5 m
Crash Barrier	: 2 x 0.5m
Minimum Vertical Clearance	: 5.50m
Radius of the Rotary	: 36.0m
Overall Radius of the Rotary	: 51.0m
Circumferential length at C/L of Rotary	: 157.0m
Type Box Girder	: Sturtted UHPFRC Box Girder

Approaches

All approaches to the Elevated Rotary Flyover at Madiwala T junction is already explained above under details of proposal for the proposed elevated corridor from Sl. NO. 4 to 14

4.4.13 Utility Relocation Plan

Proposed Project corridor is falling within the thickly populated and developed area hence all types of utilities are existing in the corridor such as Water Supply ad sewage lines (BWSSB), High Tension Power Line of 11 KV (BESCOM/KPTCL), GAS Pipeline/OFC. After consultation with concerned stake holders a lump sum provision of 8 % on the cost of Amount put to tender is reserved for shifting/reconstruction of Utilities falling within the project corridor.

There are 89 trees falling along the proposed flyover alignment, out of 37 trees are proposed for transplantation and 52 trees is have to be felled during the construction phase. As a compensatory measure, it is proposed to plant the number of trees as per forest department direction to be felled with site specific indigenous species. Apart from this there are 70 trees found to be partially affecting the alignment which are proposed for the cutting of branches only. The cost for the same is included in the estimate.

5 Traffic Study

5.1 Analysis of Existing Traffic and Forecast

5.1.1 Traffic Survey between Indiranagara – Domlur-Silk board

Classified Volume Count Survey is carried out during April 2025 on project road from Indiranagara to Domlur to Silk board and visa versa direction. Traffic flow is two way directions with 2 lane CW and 0.6m wide median. Classified Volume Count Survey is done for one day count from morning 6 am to evening 8pm for 14 hours to assess the volume of traffic flow. This location survey is analyzed to obtain the following traffic characteristics:

- Average hourly variation of traffic volume
- Average Composition of traffic
- Annalise the traffic capacity of the road

The project road observes bi direction flow of traffic about 27807 Vehicles (16656 vehicles from Indiranagar to Domlur&11151vehicles from Domlur to Indiranagar) in terms of PCU is 30137 covering Morning to Evening including Peak hours. Hourly counts of different types of vehicles are shown in the below table and composition of fast moving motorized vehicles is about 99.55 percent. The number of vehicles movement in hourly is shown in Table 5-1 below.

Time(Hours)	Standard Buses	Mini Buses	Cars/ Jeeps	Pickup Vans/ Maxicabs	Two Wheelers	Passenger Auto	2-Axle Trucks	3-Axle Trucks	MAVs	LCVs	Goods Auto	Tractor & Trailer	Bi-Cycles	Hand /Animal Drawn	Others	Total Vehicles	Total Vehicles in PCU
06.00-07.00	25	6	52	32	209	74	15	2	1	41	19	7	32	0	0	515	620
07.00-08.00	41	10	158	60	280	99	25	4	0	57	24	8	42	0	0	808	959
08.00 - 09.00	90	46	687	120	916	359	25	3	0	78	10	2	94	0	0	2430	2692
09.00 - 10.00	96	27	955	138	1471	365	16	2	0	53	17	6	21	0	0	3167	3338
10.00 - 11.00	100	12	996	204	1975	414	9	0	0	94	34	12	19	0	0	3869	3996
11.00 - 12.00	70	8	857	152	1645	321	10	1	1	117	35	9	16	0	1	3243	3332
12.00 - 13.00	23	1	513	112	723	200	22	4	0	83	25	9	33	0	1	1749	1884
13.00 -14.00	27	2	458	132	759	182	18	4	1	82	16	1	25	0	0	1707	1795
14.00 - 15.00	26	6	449	86	447	194	22	3	0	93	2	5	22	0	1	1356	1544
15.00 - 16.00	49	15	427	72	643	162	13	2	0	68	49	6	35	0	0	1541	1666
16.00 - 17.00	41	27	493	73	684	230	12	4	1	49	84	12	25	3	0	1738	1953
17.00 - 18.00	34	12	590	53	448	222	8	0	3	76	42	3	41	1	1	1534	1735
18.00 - 19.00	41	18	680	45	647	256	5	3	2	80	100	4	72	1	0	1954	2160
19.00 - 20.00	34	8	653	56	911	400	20	1	0	68	23	1	21	0	0	2196	2463
Total	**697**	**198**	**7968**	**1335**	**11758**	**3478**	**220**	**33**	**9**	**1039**	**480**	**85**	**498**	**5**	**4**	**27807**	**30137**

Table 5-1 Classified Volume Count of different types of vehicles

5.1.2 Peak Hour Traffic

Peak hour traffic of bidirectional vehicles flow at 10 am to 11 am is estimated as 3869 vehicles per hour (3996 PCU). The graphical representation of peak hour traffic flow is shown in Figure 5-1below.

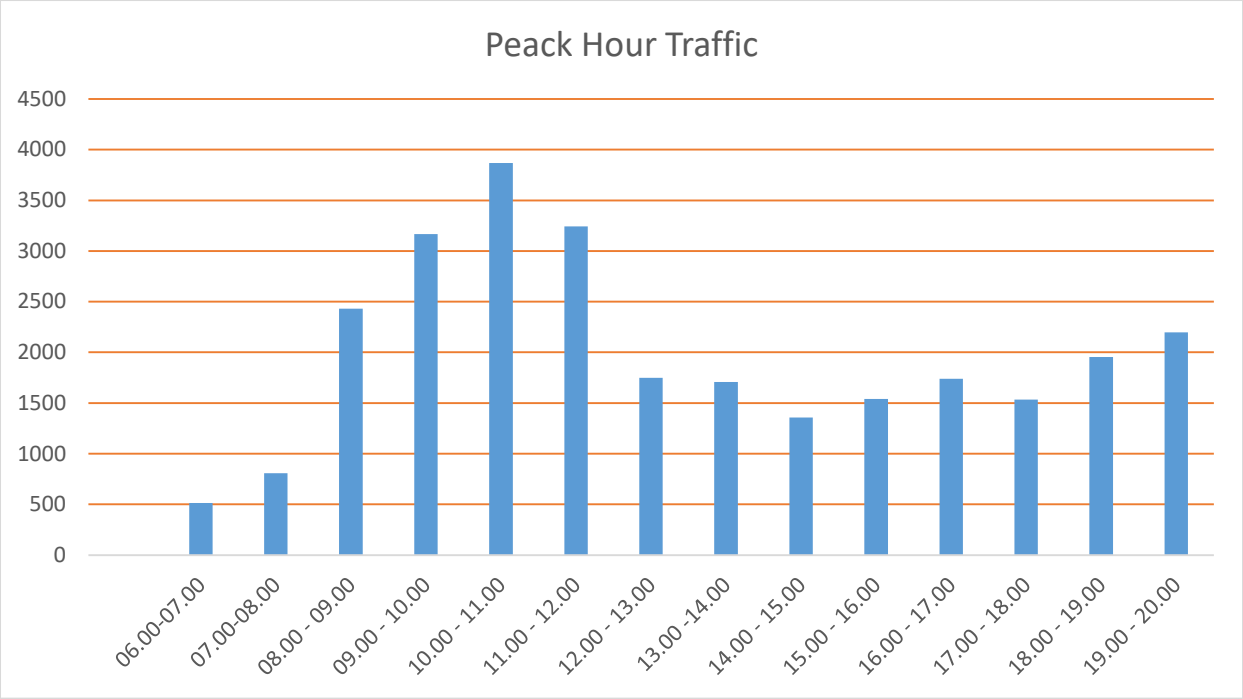


Figure 5-1Hourly Movement of Vehicle

5.1.3 Composition of Traffic

The composition of traffic has been assessed from the traffic analysis and is represented in the following**Figure 5-2**.The two wheeler vehicle composition is 11758 and composition of Car is about 7968 which is next to two wheeler.

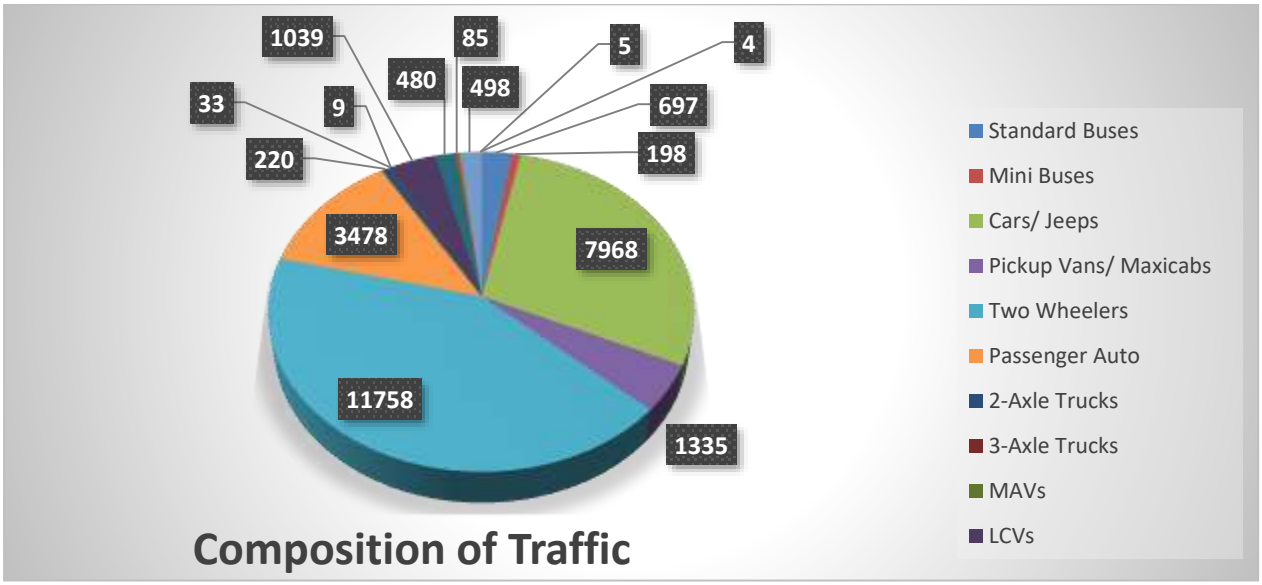


Figure 5-2Graphical Representation of Composition of Traffic

5.1.4 Growth of Traffic

From the CVC traffic study, the traffic growth is estimated on an hourly basis and the results were tabulated. Traffic growth in PCU is estimated for 25 years at 5-year intervals. The annual growth percentage of different types of vehicular traffic is assumed and tabulated in the following statements shown in Table 5-2and Table 5-2 Assumption of Annual percentage growth of various types of vehicular traffic

Time (Hours)	Present Traffic 2025-2026	Growth for 5 Years	Growth for 10 Years	Growth for 15 Years	Growth for 20 Years	Growth for 25 Years
		2027-2032	2033-2038	2039-2044	2045-2050	2051-2056
Time(Hours)	**Total Vehicles in PCU**	**Total Vehicles in PCU**	**Total Vehicles in PCU**	**Total Vehicles in PCU**	**Total Vehicles in PCU**	**Total Vehicles in PCU**
06.00-07.00	620	733	841	950	1163	1353
07.00-08.00	959	1138	1314	1490	1838	2166
08.00 - 09.00	2692	3247	3798	4349	5445	7643
09.00 - 10.00	3338	4046	4747	5451	6854	10364
10.00 - 11.00	3996	4833	5664	6498	8159	12064
11.00 - 12.00	3333	4028	4714	5401	6771	10336
12.00 - 13.00	1885	2268	2645	3022	3778	4690
13.00 -14.00	1795	2166	2528	2897	3623	4545
14.00 - 15.00	1545	1861	2168	2479	3096	3770
15.00 - 16.00	1666	2006	2339	2675	3340	4158
16.00 - 17.00	1947	2344	2732	3121	3900	4791
17.00 - 18.00	1734	2097	2453	2810	3522	4298
18.00 - 19.00	2158	2605	3043	3480	4354	5213
19.00 - 20.00	2463	2976	3484	3990	5006	5938
Total	**30131**	**36348**	**42470**	**48613**	**60849**	**81329**

The graphical representation of growth of traffic is shown in **Figure 5-3** below.

Type of Vehicles	Standard Buses	Mini Buses	Cars/ Jeeps	Pickup Vans/ Maxicabs	Two Wheelers	Passenger Auto	2-Axle Trucks	3-Axle Trucks	MAVs	LCVs	Goods Auto	Tractor & Trailer	Bi-Cycles / Cycle Rickshaw	Hand /Animal Drawn	Others
Growth of Vehicle	4%	4%	5%	5%	4%	4%	1%	1%	1%	2%	3%	1%	1%	1%	1%

Table 5-2 Assumption of Annual percentage growth of various types of vehicular traffic

Time (Hours)	Present Traffic 2025-2026	Growth for 5 Years	Growth for 10 Years	Growth for 15 Years	Growth for 20 Years	Growth for 25 Years
		2027-2032	2033-2038	2039-2044	2045-2050	2051-2056
Time(Hours)	**Total Vehicles in PCU**	**Total Vehicles in PCU**	**Total Vehicles in PCU**	**Total Vehicles in PCU**	**Total Vehicles in PCU**	**Total Vehicles in PCU**
06.00-07.00	620	733	841	950	1163	1353
07.00-08.00	959	1138	1314	1490	1838	2166
08.00 - 09.00	2692	3247	3798	4349	5445	7643
09.00 - 10.00	3338	4046	4747	5451	6854	10364
10.00 - 11.00	3996	4833	5664	6498	8159	12064
11.00 - 12.00	3333	4028	4714	5401	6771	10336
12.00 - 13.00	1885	2268	2645	3022	3778	4690
13.00 -14.00	1795	2166	2528	2897	3623	4545
14.00 - 15.00	1545	1861	2168	2479	3096	3770
15.00 - 16.00	1666	2006	2339	2675	3340	4158
16.00 - 17.00	1947	2344	2732	3121	3900	4791
17.00 - 18.00	1734	2097	2453	2810	3522	4298
18.00 - 19.00	2158	2605	3043	3480	4354	5213
19.00 - 20.00	2463	2976	3484	3990	5006	5938
Total	**30131**	**36348**	**42470**	**48613**	**60849**	**81329**

Table 5-3 A statement of progressive growth of traffic over 25 years

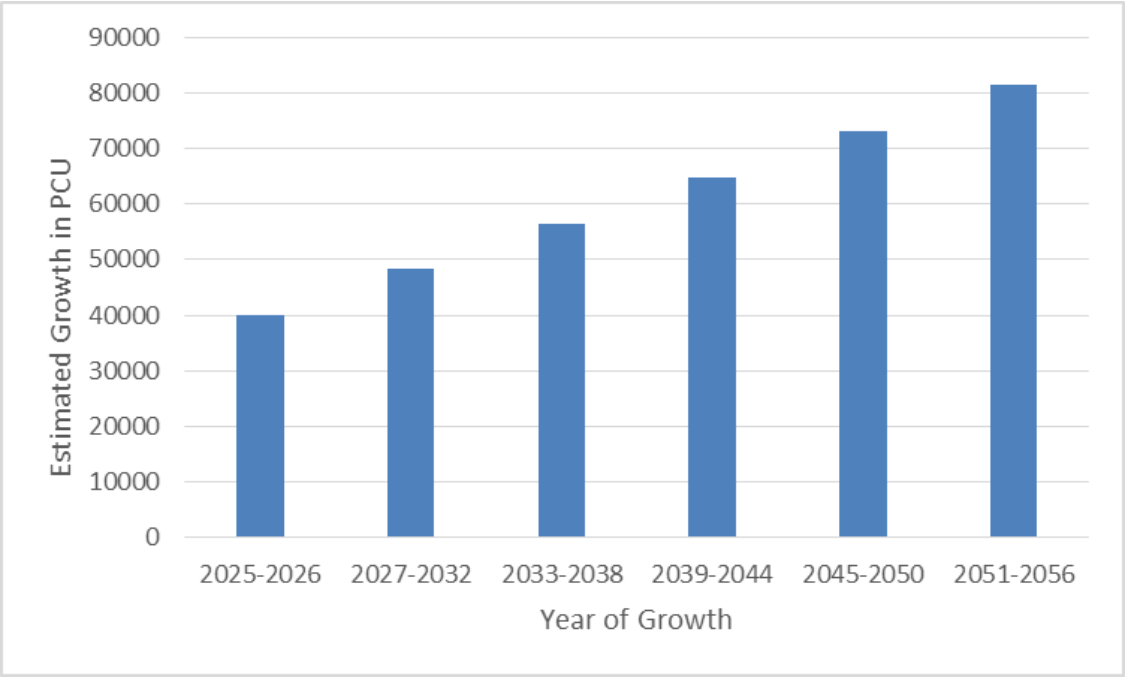


Figure 5-3Graphical representation of Growth of Traffic for next 25 years

5.1.5 Peak Hour Growth of Traffic

Maximum peak hour traffic at the time of traffic survey conducted on 2021 is 3200 PCU/hr. Peak hour traffic growth at 5-year intervals has been estimated for 25 years and is tabulated in Table 5-4 below.

Sl. No.	Year	Peak Hour Traffic/Hour (Existing Traffic in PCU)
1	2025-2026	3996
2	2027-2032	4833
3	2033-2038	5664
4	2039-2044	6498
5	2045-2050	8159
6	2051-2056	12064

Table 5-4 Peak hour Traffic/ Hour forecast for 25 years

5.1.6 Traffic Capacity of Project Road

The peak hour traffic / hour as estimated at this project road for the present year of count is 3996 to next 25 years will be12064.

As per IRC-106 1990 “Guidelines for Capacity of Urban Roads in Plain Areas” the recommended design service volumes PCU/Hour for 6 lane divided two-way traffic is 4300 for sub-arterial road (with frontage access but no standing vehicles and high capacity intersections), and whereas for 4 lane divided two-way traffic is 2900.

As per IRC guide lines/recommendations, carriageways at grade level should be designed for more than 6lanes with divider for two way traffic to accommodate 5664 V/H traffic in next 15 years in the project road. This leads to be land acquisition problem throughout the length of project and acquiring the land in urban area like Bengaluru is very costly and entire length of project is built up area and at some length with defense land.

As the PCU/hr at present year is 3996, at least 50% of the long run traffic will use elevated structure to reach their destination in short time by avoiding hurdles of junctions at grade road. Other benefits of constructing a high-rise structure on the project road include connecting different parts of the city and reducing traffic congestion. Several elevated corridors are planned to address the city's traffic problems, and this particular stretch is part of that plan

Bengaluru is experiencing rapid urbanization and a corresponding increase in vehicle traffic, leading to severe congestion on major roads like Old Madras Road and the route through Indiranagara. Existing

roads are often narrow and heavily developed, making widening at the existing level difficult and leading to land acquisition issues.

When a four-lane elevated structure is constructed, most of the long-haul traffic is diverted to the elevated structure, and this leads to the relief of traffic congestion on the grade road. There will be an 8-lane carriageway along the entire length, where an additional 4-lane elevated structure can be constructed on the existing 4-lane road without land acquisition except at certain locations, if required.

After discussion with BSMILE officials the concept of a four lane divided elevated corridor with carriageway of total width 17.20m has been proposed with two lane of 3.50m along with paved shoulder of 1.50m width, 0.5m shy off, 0.50m crash barrier and 0.60m median on either sides.

Therefore the project is justified for the proposal of improvement of project with Elevated corridor with four lane carriageway.

5.1.7 Traffic Study for Toll Assessment

A comprehensive traffic study has been conducted for the Indiranagara–Silk Board corridor, and the study analyzed vehicle counts, diversion patterns, and willingness-to-pay percentages across all categories of traffic.

From this analysis, it is revealed that the tollable traffic volume on this corridor alone is not sufficient to justify toll collection. The corridor lies within a busy city area of Bengaluru, where traffic is highly mixed and fragmented between elevated structures, down ramps, at-grade roads, and existing flyovers. While diversion rates and toll willingness were assessed, the resulting tollable traffic count remains modest and does not support the establishment of toll plazas exclusively for this stretch.

In view of these findings, the toll traffic count has not been considered for toll operations. The project is therefore proposed to be implemented under the EPC Mode of contract, ensuring that the infrastructure is delivered efficiently and made available for public usage without the burden of toll collection. This approach balances financial responsibility with public convenience, allowing the corridor to serve as a free-flowing urban mobility improvement for Bengaluru.

6 Design Drawings

The initial design for the proposed concept of elevated corridor is prepared and design drawings also prepared accordingly. These drawings are prepared to provide guidance for detailed design and to prepare detailed cost estimates.

Engineering, procurement and construction (EPC) contracts (a type of turnkey contract) are called for tender, based on this concept of the project. This type of contract is a form of contract for undertaking construction works by the private sector in large-scale and complex infrastructure projects. An EPC contractor will coordinate all detailed design; Ensure procurement and construction work and entire project is completed as required and on time.

The following list of design drawings shown in Table 6-1 Table 6-1 below are prepared and submitted as a part of project report as Volume-II.

Sl. No.	Title	Drawing No	Remarks
1	Location Map	SSP/DWG/PRJ/2025-26/18	Tender Purpose
3	Survey of India Map showing the project road	SSP/DWG/PRJ/2025-26/18-1	Tender Purpose
2	Google Earth Image showing the project road	SSP/DWG/PRJ/2025-26/18-1-1	Tender Purpose
4	RMP-2015 map showing the project alignment	SSP/DWG/PRJ/2025-26/18-2	Tender Purpose
5	Map showing district, taluk, hobli and revenue villages falling in the project road	SSP/DWG/PRJ/2025-26/18-3	Tender Purpose
6	Political Jurisdiction Map for the project road	SSP/DWG/PRJ/2025-26/18-4	Tender Purpose
7	Existing Traffic Flow pattern	SSP/DWG/PRJ/2025-26/18-5 (from Sheet No.1 to 2)	Tender Purpose
8	Topographical Survey Drawing	SSP/DWG/PRJ/2025-26/18-6 (from Sheet No.1 to 17)	Tender Purpose
9	Concept and Alignment Plan	SSP/DWG/PRJ/2025-26/18-7 (from Sheet No.1 to 12)	Tender Purpose
10	Land Acquisition Plan and Schedule	SSP/DWG/PRJ/2025-26/18-8 (from Sheet No.1 to 5)	Tender Purpose
10	L-Section	SSP/DWG/PRJ/2025-26/18-9 (from Sheet No.1 to 11)	Tender Purpose
12	Cross Sections	SSP/DWG/PRJ/2025-26/18-10-1 to 14 (from Sheet No.1 to 19)	Tender Purpose

Table 6-1 List of Drawings

7 Project Cost

7.1 Bill of Quantities

Total item wise quantities for Elevated corridor proposal for the project road are calculated as per the detailed drawings. Separate heads for all different items of work is included in the BOQ. The separate heads considered are detailed below: Civil Works, GST, Provisional cost, and Total project cost.

7.1.1 Civil Works

The project cost under civil works includes everything related to implementation of civil works including improvements of at grade roads, flyover/bridges, street lighting electrical works, and environmental works of plantation of trees, rain water harvesting works. Following are the subhead estimates under civil works.

7.1.1.1 Road works

Bill-1 Pre- construction Activities, Site Clearance & Dismantling

The quantity has been worked out for, dismantling of existing median/ white toping /flexible pavement, tree cutting and side drains for foundation works. The dismantling works are worked out based on the Proposed Typical cross sections.

Bill-2 Foundation (Pile &Pile cap):

The quantification of the Bored cast-in-situ piles including pile cap etc., are based on the measurement as per IRC standards shown in the typical cross sections. All the items which are related to completion of foundation up to Pile cap is considered in the estimate.

Bill No - 3 Sub Structures (Pier & PSC Pier cap)

The quantities related to substructure items pier, PSC precast pier cap including Pedestals, bearing, diaphragm, HYSD steel requirement, etc., are measured based on the typical cross sections in linear measurements.

Bill- 4 Super Structures (UHPFRC - U Girder)

The quantities of UHPFRC U girder, I Girder using as beam for portal frame, deck slab, etc., calculation for sub base has been worked out based on detailed LB&D dimension as per drawings.

Bill - 5 Reinforced Earth Approach ramps to super structures (RE Wall)

The quantification of Fascia of RE Panel, earthwork, geo reinforcement, friction slab etc., are considered based on the typical cross sections. The quantity calculation for these items has been worked out based on detailed LB&D dimension as per drawings.

Bill- 6Wearing Coarse for super structures

Stone Matrix Asphalt SMA with 3mm APP Polymer modified bituminous membrane is proposed the quantification of wearing course of Stone Matrix Asphalt is based on the typical cross sections showing the thickness and width of pavement layers.

Bill-7Miscellaneous, finishing items for super structures (Crash barrier, painting, Handrail etc.)

Quantity of Crash barrier, Drainage spout, down take pipe, external painting, Hand rail on crash barrier, pavement marking and road appurtenances etc., are estimated based on the standard design of IRC and quantification is based on road drawings and alignment plan.

Bill No - 8 Streetlight over flyover

The detailed quantity estimates for different components of street light over elevated corridor and its approaches has been worked out based on detailed LB&D dimension as per drawings.

Bill No -9 Noise Barrier for controlling noise on flyover

A separate quantity estimate has been worked out under this bill for Noise barrier components. The estimate is based on location of sound pollution.

Bill No - 10 Restoration of existing road after completion of flyover construction,

The quantity for restoration of road into original condition is assessed and is included in the estimate. The restoration items like, resurfacing of flexible pavement with sub base to wearing coat, for thin white topping dry lean concrete with Thin white topping items are included. Apart from the above, delisting relaying of kerb, footpath tiles etc., are also considered in the estimate.

Bill No - 11Rainwater Harvesting

Estimate also includes the provision for construction of Rain water harvesting of 4 in numbers at the locations as identified by the client. This includes brick work, aggregates size ranging from 1.5mm to boulder type as per IRC Standards.

Bill – 12Design charges @ 0.5% on total of above items 2 to 9 as per SR V-1 Sl. No 1 Page 117 as it is EPC contract.

Estimate also have provision of design charges as this contract is going to be call under EPC/HAM contract

Bill – 13 Maintenance charges

As per MORT&H standard, for stand-alone projects like Bridge/ Tunnel /flyover works: maintenance charges are calculated. The contractor shall be paid @ 0.25% of the Contract Price each for the first five years and @ 0.50% of the Contract Price each for the remaining period of five years. on total of items as per MORTH Ltr No.RW/NH-37010/4/2010-EAP(Printing) Vol.-IV Government of India Ministry of Road Transport & Highways Dated: 05.03.2019 AT Model agreement page 76 under section 14.1

7.1.2 The Project Amount Called in the Tender

The total amount estimated under the above bills from Bill-1 to 13 is the amount of civil works indicated as tender amount based on the current schedule of rate in the EOT proposal.

7.1.3 Goods &Service Tax (GST)

As per the latest GST rules the GST rate on works contract is 18% as per which the total amount is estimated to be kept as a provisional sum to be paid to the contractor at the time of passing the running bills.

7.1.4 Provisional Sum

As contingency expenditure, a provisional sum is reserved on the basis of percentage of civil construction cost to meet the following objectives.

Sl. No.	Description
1	Provision for Contingencies and Provision for Departmental Establishment Charges @ 2% on APT
2	Provision for Independent Engineer / PMC/DPR @ 1.50% on APT
3	Provision for Price escalation @ 2.5% for the 2nd year i.e., 2.5% on APT
4	Provision for utility shifting @ 8% on APT
5	Provision for Arboriculture/ Afforestation @ 0.50% on APT
6	Land Acquisition Cost including Structures
7	Miscellaneous and other Department Deposits

7.2 Rate Analysis

The unit rates have been arrived by considering the basic rates, lead distances, man power, machinery, and materials. The unit rate for every individual item will be arrived based on State PWD&IWTD Schedule of Rates, Bangalore Circle, for the year 2024-2025. Issue rates published by PWD were considered at the time of preparation estimate, i.e. 08-10-2025 & 06-01-2026.

An additional percentage for shuttering works as specified in the SR has been considered in the unit rate of the particular concrete items, according to which the total unit rates have been assessed.

Project area of construction of Elevated corridor shall be executed in the GBA limits, according to PWD SR 2024-25; the weightages of 10 percentages is added for finished items of BOQ in rate analysis.

PWD SR for Electrical works 2024-25 is used for estimating the Street light works.

BWSSB SR 2024-25 and Common Schedule of Rates is used.

Indian Railway Unified Standard Schedule of Rates 2019 is used to estimate the cost of transportation of UHPFRC Girders /Pre cast pier cap from casting yard to project site for innovative structure of elevated corridor. This SR is also used to derive the data rate.

The Items which are not available in any of state SR, the rate analysis for such items are derived from the available SR items and are shown in rate analysis estimate sheets enclosed at the end of this chapter.

7.3 Estimated Costs

Costs summary of the proposed Elevated Corridor project is presented in the following the total estimated Project cost is Rs. 1300.00 Cr. Detailed item-wise estimated bill of quantities and rate analysis is enclosed in this report.

Abstract of Estimate (Issue rated dated : 08-10-2025 & 06-01-2026)

Sl. No.	Description	Amount in Rs	Percentage of Components
1	Pre- construction Activities, Site Clearance & Dismantling	34110065.51	0.400
2	Foundation (Pile &Pile cap)	1993957879.00	23.4
3	Sub Structures (Pier & PSC Pier cap)	455646986.00	5.3
4	Super Structures (UHPFRC - U Girder)	4886606070.00	57.4
5	Reinforced Earth Approach ramps to super structures (RE Wall)	33813290.00	0.4
6	Wearing Coarse for super structures (SMA)	79522423.00	0.9
7	Finishing items for super structures (Crash barier, painting,Handrail etc)	172921238.00	2.0
8	Streetlight over flyover	46773635.71	0.5
9	Noice Barrier for controling noice on flyover	13175593.20	0.2
10	Reconstruction of White topping road at approaches with all allied works	188325972.60	2.2
11	Restoration of existing road after completion of flyover construction and Rainwater Harvesting	252848685.83	3.0
12	Re construction of Compoundwall at LA Location for Govt and private properties.	10508163.92	0.123
13	**Credit for Dismantled Material:** Deduct Salvage values from Dismantaled structures like SSM masonary(,scarp material Steel 151.55 MT(from Existing ROB structures, RE Wall) RE earth from Dismantaled Existing RE wall structures 60% of existing earth is considered for reuse during new RE wall structures.	-116696.23	
14	Provision for Design charges @ 0.57% on total of above items from Sl. No. 2 to 12	46364369.64	0.5
15	Maintenance charges for stand-alone projects like Bridge/ Tunnel /flyover works: the contractor shall be paid @ 0.25% of the Contract Price each for the first five years and @ 0.50% (including Miscellenious charge of Rs. 5,13,576.29) of the Contract Price each for the remaining period of five years. on total of items as per MORTH Ltr No. RW/NH-37010/4/2010-EAP(Printing) Vol.-IV Government of India Ministry of Road Transport & Highways Dated: 05.03.2019 AT Model agreement page 76 under section 14.1 d	305542323.83	3.6
16	**Amount Put to Tender (APT) Excluding GST**	**8520000000.00**	**100.0**
17	Goods and Service Tax (GST) @ 18% on APT	1533600000.00	4480000000.00
18	**Total Civil Construction Cost (APT+GST)**	**10053600000.00**	
19	Provision for Contingencies and Provision for Departmental Establishment Charges @ 1.90% on APT	161880000.00	
20	Provision for Independent Engineer / PMC @ 1.50% on APT	127800000.00	
21	Provision for Price escalation @5% ,for the 2nd year i.e., 2.5% on APT	213000000.00	
22	Provision or utility shifting @8% of Project cost (APT)	681600000.00	
23	Provision for Arboriculture/ Afforestation @ 0.5% on APT	42600000.00	
24	Land Acquisition Cost including Structures	1713867954.85	
25	Miscellenous and other Department Deposits	5652045.15	
26	**Total Capital Cost of the Project**	**13000000000.00**	
Estimated cost in terms of Area in Sqm and Length in Km			
27	Cost / Sqmt (deck 111572.9 sqmt) for structure alone (considering cost of Foundation+sub+super structure + Wearing course + Finishing works) = Rs. 70474 / sqmt (Justification for cost is enclosed)	**On Amount Put to Tender**	**On Total Project Cost**
28	Cost/Sqmt including all items from Sl. No. 1 to 15 / Cost/Sqmt including all items from Sl. No. 1 to 25	**72913.00**	**111251.00**
29	Cost/Km Viaduct length 12469 + Approach 0.580 km Total Length = 13.049 km	**652923596.00**	**996244923.00**

Table 7-1Project Cost Estimate

7.4 Compensatory afforestation

According to the NGT and the Ministry of Environment, it is proposed to plant the trees at a ratio of 1:10, i.e. planting ten trees against losing one tree.

In this project, about 235 trees are coming under construction width of corridor, most of the tress its branches are affecting, however it is planned to plant around 2350 fresh plantations wherever possible in and around Bengaluru city area.

An amount of **₹4.26 crore** has been provisioned towards arboriculture and afforestation under the estimated project cost.

7.5 Re-usage of released materials

Various items of materials dismantled from existing RCC flyover, drain, footpaths, curbs and covered drains, etc., are proposed for to maintain a proper account and are proposed for recycled or auctioned based on quality of the items observed. The amount of material.

BSMILE have been requested to put a following specific condition in the Tender document for re-usage materials from dismantled items that,

1. All salvage materials as listed in the following Schedule of Credit shall become the property of contractor (when the work is awarded on tender basis) and salvage is already affected as deduction in the total project cost.
2. The materials enumerated below shall become the property of the contractor. These materials shall be allowed to be removed from site as the salvage value is already adjusted in the project cost.
3. The rate fixed by department is firm. The contractor shall have no claim whatsoever against the department if actual rate turns out to be different from the rates inserted by the department.
4. The amount of credit in respect of items shown below shall be provisional and actual quantities shall be measured in MB against each item shall be considered for arriving total amount of credit.
5. Items if any obtained from demolition/dismantling but not listed below shall become the property of government and accordingly shall be handed over to BSMILE without any extra payment.

Sl. No. / Item No	Items	Unit	Quantity in BOQ Nos	Quantity of Re usage materials Can seggregated/ Unit	Current Material Rate as per SOR 24-25 Material/Market rate	Salvage rate considered/ Unit	Amount (Rs)	Remarks
1	2	3	4	5	6	7	8=5x7	9
3 to 5 in preconstruction Bill	Cutting of trees	MT	3	15	5000	2500	37500	Quantity of wood from felled trees can be expected as average 5MT per tree
9	Telephone/ Name board/signal post/Electrical poles	Nos	0	0		0	0	All Electri poles are very old and entilre poles to be handed over to BBMP/BESCOM Electrical maintanance department.
2	Dismanteling of concrete	Cum	4192.8	419	640.12/cum	100/cum	41928	aggregates on 10% of dismanteled qnty can be re used, about 15% of dismanteled SR rate is considered for salvage vaue
	Hysd steel	Cum	62.9	Hysed steel 15kg/cum=8200kg (8.2MT) for 547.2 cum	Rs79011/tonne as per CSR V-1 2.11h	Rs39505/tonne (50% of SR Issue rate is considered)	37268	Scrape material =8.2x39505
Total Salvage							**116696**	

7.6 Structural Area Statement

Sl No	Description	Chainage	Viaduct length	Approach length	Total Length	Width of Viaduct	Area of Viaduct
1	Indiranagara from Rotary along 80feet road via 100ft road	Ch 100 to 2925	2825	100	2925	12	33900
2	down ramp to Indiranagara at Rotary junction near C V Raman General Hospital	Ch 100 to 310	110	100	210	7	770
3	Down ramp to Old madras road at Rotary junction near C V Raman General Hospital	Ch 107 to 357	150	100	250	7	1050
4	from chainage 2+575 to 3+587 to cross existing Domlur interchange including taper length of 150m &2 m additional length due to double level	Ch 2+575to 3+587+2	914	100	1014	7	6398
5	up ramp from Sarjapura Approach including tapering of 150m	ch 0 to 190+150m tapering	240	100	340	7	1680
6	Ejipura to Madivala rotary	Ch 8+368 to 8+728.5 (LHS+RHS)=360.5X2=721M	721	Nil	721	8.5	6128.5
7	Proposed Audgodi loop INCLUDING 7 M & 17.2 M CW	Ch 0 to 360 (LHS+RHS) + TAPERING 2 X 120M for both loop+Ch 360 to 562 17.2m cw	960	Nil	960	7	6720
			202	Nil	202	17.2	3474.4
8	Audgodi loop to Silkboar contnd	Ch 562 to 682	120	Nil	120	8.5	1020
9	Tunnel approach connecting to Audgodi loop170m with	290	210	80	290	7	1470

Sl No	Description	Chainage	Viaduct length	Approach length	Total Length	Width of Viaduct	Area of Viaduct
	tapering length of 120m						
10	Double deckar flyover from Banashakari to Madivala junction including taper length of 120m+30m of joint connecting at ch 270	634	634	Nil	634	7	4438
11	From Rotary to Hosur crossing Double deck flyover towards Hosur , HSR Layout 200m and Hosur to Madivala side Ch 8+782 to 9+766 = 2011m	Nil	Nil	Nil	Nil	Nil	Nil
12	8+782.5 to 8873 (LHS) 90m+RHS 878.25 towards Masjid -90m	2078 M	180	Nil	180	8.5	1530
	8+873 TO 9191		318	Nil	318	17.2	5469.6
	Double level from 9+766 TO 9191 (LHS+RHS)= 575 X 2+ add 2m for additional length due to double level		1152	Nil	1152	8.5	9792
	from ch 9561 - Towards HSR road loop 200m + taper length of 150m		350	Nil	350	7	2450
13	Rotary at Madival junction		157	Nil	157	17.2	2700.4

Sl No	Description	Chainage	Viaduct length	Approach length	Total Length	Width of Viaduct	Area of Viaduct
14	Flyover from Silk Board to Electronic city flyover Ch 9820 to 10975+ taper length on either side with 120m		1395	Nil	1395	7	9765
15	Electronic city to Banashankari double deckar Ch 0.00 to 1591+tapering of 120m length at start and end		1831	Nil	1831	7	12817
16	Total Length of Visduct and Approach		**12469**	**580**	**13049**		
17	Total Length of split flyover including Approaches (LHS+RHS)		**13049**				
18	Total area of Viaduct						**111572.9**

7.7 Justification for Project Cost

NHAI data (Normative Cost) for cost-estimates of National Highways is updated by the Ministry of Road Transport and Highways from time to time and a standard cost per square meter for roads and structures has been arrived at based on various assumptions.

The standard costs obtained on the basis of NHAI circular dated 25/04/2018 are being used only for comparison during appraisal and approval of projects.

The standard cost of an elevated flyover with high strength concrete prepared by MORT&H is as follows and is compared with BSMILE elevated projects proposed for construction with UHPFRC superstructure elements.

Although the table below indicates that the initial cost of structures using UHPFRC is higher than the standard construction cost, the following facts demonstrate that the use of UHPFRC remains economical and justified when compared to conventional methods.

Statement showing the MORT&H Normative cost with Escalation @ 5% from 2018 to 2025						
Normative Cost during the Year 2018 for Plain Terrain Rs. in Cr						
Comparison of Bridge cost	Description of Work	Bridge Proper Cost	Bridge Proper Total Cost	Approach	Total Cost (Bridge+ Approach)	Bridge Proper Cost (Per Sqmt)
MORT&H	**Elevated structure like Flyovers 4 lane carriageways**	**0.003**	**2.98**	**12.15**	**15.13**	**0.004**

Normative Cost with price escalation @ 5% from 2018 to 2025 year for Plain Terrain Rs in Crore							
Bridge Proper Cost (Per sqmt) FOR 2018 Year	Bridge Proper Cost (Per Sqmt) @ 5% for2019 Year	Bridge Proper Cost (Per Sqmt) @ 5% for2020 Year	Bridge Proper Cost (Per Sqmt) @ 5% for2021 Year	Bridge Proper Cost (Per Sqmt) @ 5% for2022Year	Bridge Proper Cost (Per Sqmt) @ 5% for2023 Year	Bridge Proper Cost (Per Sqmt) @ 5% for2024 Year	**Bridge Proper Cost (Per Sqmt) @ 5% for2025 Year**
0.004	0.0042	0.00441	0.004631	0.004862	0.005105	0.00536	**0.005628**

The National Highways Authority of India has prepared a DPR in the year 2022 for the project of construction of Flyover from Indora Chowk to Dighori Chowk in Nagpur city on NH 353D on EPC Mode in the State of Maharashtra. The flyover cost as per the DPR estimate is shown in the Table below with escalation price as on 01-09-2025.

Statement showing the Nagpur DPR cost with Escalation @ 5% from 2022 to 2025						
Flyover structure Cost during the Year 2022 for Plain Terrain Rs in Cr						
Comparison of Bridge cost	Description of Work	Foundation, substructure Super structure	Super structure	Fixed cost	Total Cost)	Bridge Proper Cost (Per Sqmt)
NHAI	**Nagpur project work (**Indora Chowk to Dighori Chowk) **as described above**	**90.84**	**277.2**	**24.68**	**392.72**	**0.0045**

Normative Cost with price escalation @ 5% from 2018 to 2025 year for Plain Terrain Rs in Crore			
Bridge Proper Cost (Per sqmt) FOR 2022 YEAR	Bridge Proper Cost (Per Sqmt) @ 5% for2023Year	Bridge Proper Cost (Per Sqmt) @ 5% for2024Year	Bridge Proper Cost (Per Sqmt) @ 5% for2025Year
0.0045	0.00472	0.00496	0.00520

Statement showing the proposed Elevated flyover project from Swamy Vivekananda Metro to Silk board junction for the year 2025						
Flyover structure Cost during the Year 2022 for Plain Terrain Rs. in Cr						
Comparison of Bridge cost	Description of Work	Foundation, substructure	Super structure	Fixed cost	Total Cost)	Bridge Proper Cost (Per Sqmt)
Project	**Indiranagara to Silkboard Junction**	**241.29**	**515.93**	**33.72**	**790.95**	**0.0070**

Comparison of Flyover cost per square meter compare to Normative cost of MORT&H, NHAI Nagpur DPR Cost and Proposed Project cost is made comparison in the following Table.

Statement showing the Comparison cost of Flyover		
Flyover structure Cost during the Year 2025 for Plain Terrain Rs in Cr		
Comparison of Bridge cost	Description of Work	Bridge Proper Cost (Per Sqmt)
MORT&H	**Normative Cost**	**0.0056**
NHAI Project of Nagpur	**DPR Cost**	**0.0052**
Proposed Project	**DPR Cost**	**0.0070**

Elevated Corridor Project cost /sqmt on Amount put to Tender	
Amount put to Tender	**Rs. 8520000000.00**
Structure Area (Viaduct and Approaches) in Sqmt	**1,11,572.90 Sqmt**
Cost /Sqmt	**Rs. 72,913.00**
Normative Cost as per MORTH Updated with price escalation @5% from 2018 to 2025 year	**Rs. 56,280 .00**
Difference between Normative Cost/Sqmt with project details	**Rs.16,663.00**

For arriving normative cost, the Committee's chaired by MORT&H senior officials had made a various assumption to calculate the Normative cost which are as follows:

Flyover for 4 lane carriageways

Sl No	Description of structure	Type of Structures components
1	Type of Foundation	Pile foundation with steel liner 15m depth
2	Type of Pier	Circular
3	Vertical Clearance	5.5m
4	Span arrangement	10m+20m+10m =(40m)
5	Super structure	Prestressed Girder type
6	Width of Carriageway	As per IRC Mannual

Comparison of normative cost of elevated flyover between High Strength Concrete of M-50 -60 with M-150 TO 200 UHPFRC Structures on Amount Put to Tender.

Sl. No	Description	As per Normative cost for conventional High strength Concrete	If the UHPFRC technology is adopted	Remarks
1	Span	10 x 2 + 20 x 1 =45m	Single span of 45 x 1	No intermediate pier support
2	Number of Pile/ Pile cap /Pier	16 piles, 4 Nos of Pile cap and Pier	8 Piles, 2 Numbers of Pile cap/Pier	50% of structure items are get reduced results in terms time period reduces.
3	PSC Girders	16 to 18 PSC Girders, with thick structures and heavy weight for 3 span	4 Girders for 40m span, light in weight	
4	Time of Construction	Minimum one year	Maximum 3 months	Saved in Cost over run
5	Normative cost per Square meter	Rs 56,280/sqmt		Which includes only Foundation/Substructure/Super structures wearing course approaches and excluding other costs of a. Pre-construction activities, design charges/Maintenance charges/Restoration of existing road with re construction/Noise barrier, Traffic sinages ETC.,
			Rs72,913/Sqmt on Amount estimated for Tender	This amount includes every things which are excluded in the Normative cost as indicated above in remarks.

The proposed elevated corridor is designed for execution using conventional method of PSC Box girder high-strength concrete of M-50 to M-60 grade. The estimated cost of structures has been worked out at ₹1,18,405 per sq. m, reflecting an increase of more than 62% in cost per square meter when compared with conventional designs.

However, by adopting Ultra-High Performance Fiber Reinforced Concrete (UHPFRC) for girders in the superstructure, significant savings can be achieved:

• Approximately 34% reduction in piles, 42% in piers, and pier caps, resulting in both cost and time savings.

• For a normative single-span structure constructed with UHPFRC, the cost per square meter is assessed at ₹25,000 per sq. m, which is substantially lower.

Comparison with Normative Costs

• The Ministry of Road Transport & Highways (MoRTH) has considered normative rates per square meter for works in rural and district areas, which do not reflect the higher costs associated with urban cities like Bengaluru.

• When compared with similar projects of the MoRTH and NHAI, such as the Nagpur DPR, the proposed project cost is justifiable. Table below justifies the initial cost per sqm of UHPFRC

Parameter	MoRTH Benchmark	UHPFRC	Conventional M50 (30m span)	Remarks
Cost per sqm	₹40,000	₹70,474	₹111,958	UHPFRC higher upfront, but significantly lower than conventional M50 for this corridor
Design Life	40–50 years	100 years	40–50 years	UHPFRC doubles lifespan, reducing long-term replacement needs
Maintenance	High (rehabilitation every 10–15 yrs)	Minimal	Moderate	UHPFRC reduces O&M costs due to superior durability
Span	30m	45m	30m	Longer span reduces number of piers, foundations, and land acquisition
Urban Utility Impact	Moderate	High	High	Corridor complexity factored; UHPFRC minimizes disruption by reducing pier density
Lifecycle Cost	Higher	Lower	Highest	UHPFRC most economical over 100 years when lifecycle savings are considered

While the initial cost per sqm is higher, the total lifecycle cost is significantly lower, and the choice of UHPFRC is both technically and economically justified.

8 Environmental Impact Assessment Study

8.1 Back Ground

Bengaluru's vehicle population has been growing day by day and the city roads are being added roughly 5 lakh vehicles every year. By June 2025 total vehicle population in Bengaluru is reached about 1.2 Crore, the number of non-transport vehicles such as two-wheelers and cars in the city had reached 1.06 Crore. According to State Transport Department, two-wheelers are numbering over 81.9 lakh followed by cars numbering 23.59 lakh. Number of transport vehicles stands at over 10.89 lakh. These numbers exclude the vehicles that come in and go out of the city. This out growing numbers vehicles are choking the city roads with frequent traffic jams and have made traffic police helpless.

Further, for various known reasons public is using the independent modes of transportation for commuting on existing limited road network adding to the congestion, accidents, noise and air pollution. As per the report on Comprehensive Traffic and Transportation Plan for Bangalore (CTTP) – 2011, an average Bangalore an spends more than 240 hours stuck in traffic every year and such delays are resulting in loss of productivity, in addition to deterioration of air quality, reduced quality of life, and increase in costs for services and goods.

The concept of elevated corridor evolved to counter the traffic woes of the city in the form of traffic congestion and provide solution for many of the traffic related problems. The project is envisaged to separate the cross-city traffic and the neighborhood traffic, with an aim to decongest the core city and provide easy access to suburban towns and Bengaluru International Airport. The project is planned based on two traffic directions of the city - North-South and East-West, with interconnecting and loop elevated corridors. The basic idea is to decongest at grade roads by creating an additional capacity in the form of elevated corridors. This enhances the traffic carrying capacity of the roads at grade. As the widening of Bengaluru city roads is not possible, we are only left with the option of going vertical by elevated corridors.

In this context, Government of Karnataka has planned for elevated corridors to ensure safe, fast and congestion free connectivity to different parts of city. The issues relating to traffic and transportation in a large and growing city like Bangalore need to be viewed in the larger perspective of urban planning and development. Issues relating to land use planning and development control, public-private transportation policy and industrial location would need to be integrated at the perspective planning level. With Metro Rail under implementation there is the need to coordinate inter modal transport issues.

8.2 Land Use and Roadside Environments

The observed land use pattern is predominantly residential layout formed by the Bangalore Development Authority, as the city grew, residential units along the main road were leased out to commercial activities and the road itself became predominantly commercial.

There are bus stops with shelters along the corridors, skywalks/foot over bridges, gantry sign boards, street lights like high mast lamps, etc. are also in place. The project corridors are surrounded by important community structures such as schools, colleges and places of religious importance such as temples, mosques and churches. The implementation of the project will not affect these structures and the compound wall may need to be relocated in some places to avoid the impact.

Some sections of the project corridors adjoining the land belong to Defense, public sectors like HAL and educational institutions. Some religious structures also exist

The start of the project road, which deviates from the main road connecting the National Highway towards K R Puram and the heart of Bangalore city, is very close to the Eastern Terminal Railway Station and Metro Depot at Baiyappanahalli. This project road mainly connects K R Puram to Silk Board towards Hosur via Indiranagara and Domalur in the southeast of Bengaluru. The traffic intensity has increased due to the development of the areas around the project road.

Traffic growth rates have been estimated based on the traffic flowing on the project road. The overall traffic growth rates for the next 25 years have been estimated considering the annual growth rate (%) of various vehicle types as mentioned in the above Table-6.1 and in Fig 6.1 in chapter 6-

As per the traffic study the project corridor carries a traffic of 3996 vehicles/hour at peak time, whereas the maximum capacity of traffic that can be handle by project road at present for a road width of 20m with four lane is about 2800 vehicles/hour. There is now a need to widen the road to accommodate the next 5 to 25 years traffic growth of 4833 to 12064 vehicles per hour.

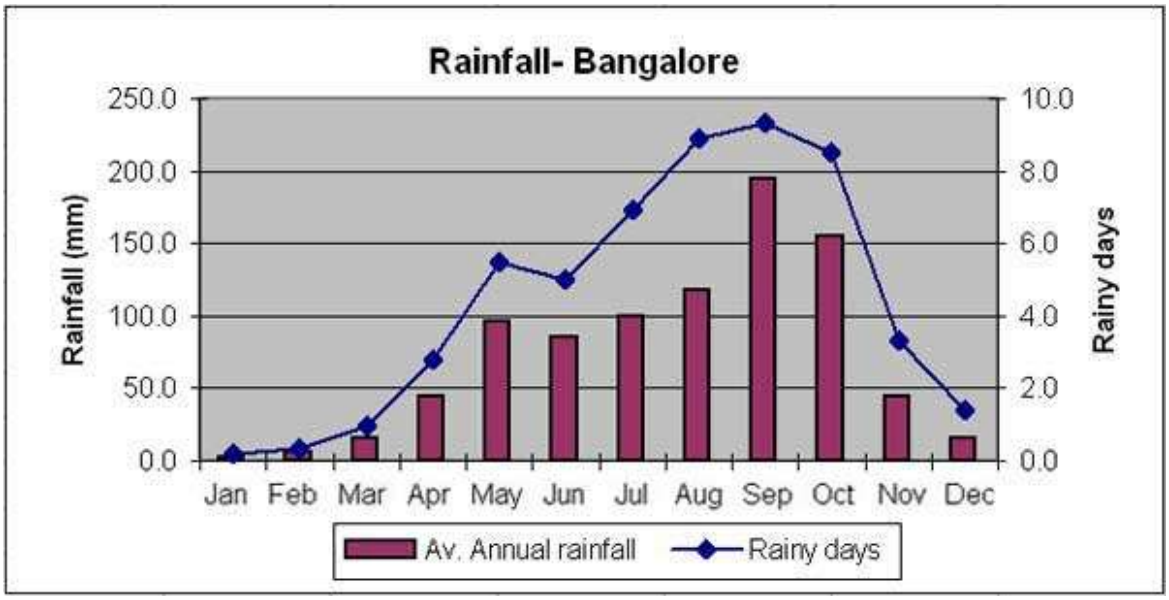
Since widening of the roads in Bengaluru city is not possible, we are left with the only option of going vertically through elevated corridors.

This elevated corridor aims to separate inter-city traffic and neighborhood traffic, reducing congestion in the major city and providing easy access to suburban towns and the Bangalore International Airport. The basic idea is to reduce congestion on at-grade roads by creating additional capacity in the form of elevated corridors. This will increase the traffic capacity of at-grade roads.

8.2.1 Climate

Bengaluru has a tropical Savanna climate with distinct wet and dry seasons. January is the coolest month in Bangalore, with an average low temp of 15.1°C. April is the hottest, with an average high of 34.1°C. The highest temperature ever recorded in the city was 39.2°C on April 24, 2016. The lowest temperature

ever recorded was 7.8°C in January 1884. In winter, usually the temp doesn't fall below 14°C, and in summer go above 36°C. The city gets rain from both the north east and southwest monsoons. The city gets a yearly rainfall of around 975 mm on average, with significant variations throughout the year. September typically receives the highest rainfall, followed by October and August. The period from June to October generally accounts for the majority of the annual rainfall. The graphical representation is shown in the figure below. The average speed of the wind is 3.4 m/s, with a maximum of around 11 m/s.



8.2.2 Humidity

The average annual relative humidity in Bengaluru is 65.2% and average monthly relative humidity ranges from 45% in March to 79% in August. On an average, July is the most humid and January is the least humid month.

8.2.3 Temperature

The highest temperature ever recorded in Bengaluru was 41.8°C in Kengeri on April 30, 2024. The lowest temperature recorded was 7.8°C in January 1884.

8.3 Legal Frame work of Government of India

The Government of India has laid out various policy guidelines, acts and regulations pertainingtosustenanceofenvironment.TheEnvironment(Protection)Act,1986provides umbrellalegislationfortheprotectionofenvironment.AsperthisAct,theresponsibilityto administerthelegislationhasbeenjointlyentrustedtotheCentralMinistryofEnvironment, Forests and Climate Change (MoEF & CC)and the Central Pollution Control Board(CPCB)/ StatePollutionControlBoard(SPCB).ThelistsofmostrelevantGovernmentofIndiaregulations and applicability to this project are provided in the following sections

8.3.1 Key Environmental Laws and Regulations

ThelistsofmostrelevantGovernmentofIndiaregulationsareprovidedintheTable 8-1

Act/Rules	Objective	Applicable Yes/No	Reason for applicability	Authority
The Environment (Protection) Act	To protect and improve overall environment	Yes	A shall Environmental notifications, rules and schedules are issued under this act.	MoEF& CC. Gol; DoE, State Gov. CPCB; KPCB
The Environmental Impact Assessment (EIA) Notification	To provide environmental clearance to new development activities following environmental impact assessment	No	This notification is not applicable to this Project roads, as they do not attract the condition of obtaining prior environmental clearance as per the Notification.	MoEF& CCSEIAA
The Forest (Conservation) Act 1980	To check Deforestation by restricting conversion of forested areas into non- forested areas	No	The project roads do not pass through forest land.	Forest Department, Govt of Karnataka
MoEF& CC circular on linear Plantation on roadside, canals and railway lines modifying the applicability of provisions of forest (Conversation) Act, to linear Plantation 1998	Protection / planting Road side strip as avenue/strip plantations as these are declared protected forest areas.	No	Roadside tree plantation in Karnataka is primarily governed by the Karnataka Preservation of Trees Act, 1976, and not the Karnataka Forest Act.	MoEF& CC
The Water (Prevention and Control of Pollution) Act and Cess Act of 1977 as amended to date. 1974	To control water pollution by controlling emission & Water pollutants as per the prescribed standards	Yes	This act will be applicable during construction for (establishments of hot mix and concrete plant, construction camp, workers' camp, etc.	KSPCB
The Air (Prevention and Control of Pollution) Act as amended to date 1981	To control air pollution by controlling emission and air pollutants according to prescribed standards	Yes	This act will be applicable during construction; for obtaining NOC for establishment of hot mix and concrete plant, workers' camp, construction camp, etc.	KSPCB
The Noise Pollution (Regulation and Control) Rules 2000	Noise pollution regulation and controls	Yes	This act will be Applicable as vehicular noise on project routes required to assess for future years and necessary protection measure need to be considered in design.	KSPCB
The Biological	To provide		Preserve	

Act/Rules	Objective	Applicable Yes/No	Reason for applicability	Authority
Diversity Act 2002	mechanism for equitable sharing of benefits arising out use of traditional biological resources and knowledge		Biological resources	
The Environment (Protection) Act	Eco sensitive Zone around NP/Sanctuary.	No	This is not applicable as no Wildlife sanctuary fall within 10km radius from project road sections	Chief Conservator Wildlife, Wildlife Wing, Forest Department, Govt. of Karnataka
The Ancient Monuments and Archaeological sites & Remains Act	Conservation of Cultural and Historical remains found in India	No	This act not applicable as the project routes are not close to any Ancient Monument, declared protected under the act.	Archaeological Dept. Gol, Indian Heritage Society and Indian National Trust for Art and Culture Heritage (INTACH).
Notification for use of fly ash	Promoting the Utilization of fly ash in the manufacture of building materials and in construction activity within a specified radius of one hundred kilometers from coal or lignite based thermal power plants	No	There are no coal- Based thermal power plants Located within a 100km radius of Bengaluru.	
The Explosives Act (&Rules)	An Act to Regulate the manufacture, possession, use, sale, transport, import and export of Explosives	Yes	For transporting and storing diesel, bitumen etc.	KSPCB
The Public Liability Insurance Act	Protection form hazardous material sand accidents.	Yes	Contractor need to stock hazardous material like diesel, Bitumen, Emulsions etc.	KSPCB
The Coastal Regulation Zone	To regulate Activities in the coastal zone to protect ecologically sensitive areas.	No	The project road Is far away from coastline	SCZMA ,MoEF & CC
The Hazardous Wastes (Management, Handling and Trans boundary Movement) Rules	Storage, handling, transportation and disposal of hazardous waste	Yes	Storage and handling of hazardous waste durin construction	KSPCB
The Municipal Solid Wastes (Management	Management and handling of solid waste	Yes	For disposal of solid wast generated durin construction	KSPCB

Act/Rules	Objective	Applicable Yes/No	Reason for applicability	Authority
& Handling)Rules				
The Batteries (Management & Handling) Rules as Amendment Rules	Management and handling of used lead batteries	Yes	Safe disposal of Used lea batteries	KSPCB
The E-Waste (Management & Handling) Rules	Effective Mechanism to regulate generation, collection, storage, transport, import, export e cycling, treatment and disposal of e- wastes.	Yes	Handling of e- Waste	KSPCB
The Central Motor Vehicles Act Karnataka Motor Vehicle Rules	To control Vehicular air and noise pollution.	Yes	This rule will be applicable to road users and construction machinery.	Motor Vehicle Department
The Minor Mineral and concession Rules	For opening new quarry.	Yes	Regulate use of minor minerals like stone, soil, river sand etc.	District Collector
The Mining Act	The mining act Has beenng activity.	Yes	The construction of project road will require aggregates. These will be procured through mining from quarries	Department of mining, Govt of Karnataka
The National Forest Policy1952 National Forest Policy(Revised)	To maintain Ecological stability through preservation and restoration of biological diversity.	NO	This policy will Not be applicable as NO eco sensitive feature exists along the Project corridor.	Forest Department, Gol and Govt of Karnataka
The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act	Set out rules for fair compensation and acquisition of land	Yes	This act will be Applicable as there will be acquisition of land for widening, geometric improvements and realignments of elevated corridor.	Revenue Department State Government.

Table 8-1 Environmental Regulations of Government of India

9 Review of Detailed Project Report by Expert Committees

The Detailed Project Report (DPR) concludes with an overall summary of the project, along with recommendations and compliances relevant to its implementation.

9.1 Expert Committees Review

The DPR was reviewed by the following Technical committees, and their discussions, observations, and compliance notes are also detailed below:

1. GBA Technical Advisory Committee – 22.08.2025
2. Bengaluru Metro Rail Corporation Limited (BMRCL) – 13.11.2025
3. Directorate of Urban Land Transport (DULT) – 29.01.2026 to 06.02.2026
4. Traffic Police Commissioner Bengaluru
5. Bengaluru Electricity Supply Company (BESCOM)
6. Bengaluru Water Supply & Sewerage Board (BWSS&B)
7. State Level Environment Impact Assessment Authority- Karnataka
8. National Highways Authority of India Regional Office Bengaluru

9.1.1 Discussion at GBA Technical Advisory Committee Meeting

During the preliminary stage of the project, prior to review by the Technical Committee, the Detailed Project Report (DPR) was prepared with a proposal for a four-lane elevated flyover incorporating an elevated rotary interchange at the Swami Vivekananda Metro Station.

The elevated four-lane structure along 80 Feet Road from Swami Vivekananda Metro Station in Indiranagar was designed to continue and integrate with the existing Domlur flyover interchange. Following the Domlur interchange ramp towards Koramangala, a new proposal was introduced for an elevated four-lane flyover extending into the built-up area, with a gap at the existing approach ramp. The proposal for a flyover from Defence Land to Ejipura Junction was not recommended.

The elevated flyover currently under construction up to St. John’s Hospital in Ejipura has been retained without modification. It is further proposed to continue the elevated road through the Madiwala underpass, connecting from the Ejipura approach to the Madiwala side, and extending through Silk Board Junction to link with the existing Electronic City Flyover.

The DPR, detailing the alignment of the elevated corridor from Swami Vivekananda Metro Station to Silk Board Junction, was presented at the Technical Committee meeting. The estimated project cost for the proposal was ₹1,202 crore. The DPR was reviewed by committee experts during the meeting held on 22-08-2025.

After reviewing the DPR and conceptual plan, the committee members suggested corrections and modifications to ensure seamless integration of the proposed project with Silk Board Junction and the

Electronic City Flyover, including the provision of loops connecting to the Double-Decker Flyover on both sides.

Modification of DPR

Following the committee's recommendations, the DPR was revised in consultation with officials of the BSMILE office. Key modifications included:

The Detailed Project Report (DPR) has been modified to propose an elevated two-lane flyover from Indiranagar, eliminating the earlier plan for a flyover beyond the Domlur interchange approach on the Koramangala side.

At the Madiwala underpass, the concept plan has been revised to integrate:

a) The under-construction Ejipura flyover,
b) The proposed flyover from Adugodi to Madiwala underpass, and
c) The alignment with the existing double-decker metro flyover from Ragigudda and the Hosur Road flyover at Silk Board Junction, ensuring seamless connectivity to the Electronic City Flyover.

The project cost has accordingly been revised to ₹1,300 crore.

9.1.2 Review by various Organisations of Government

The Director (Technical), BSMILE, has formally communicated through official letters to various Government organisations, as listed above section 9.1, to inform them about the major project of a 126.31 km Elevated Corridor currently under planning and approval for implementation. Copies of these letters addressed to the respective departments are annexed in this project report.

In addition, the technical heads of these organisations were invited to the BSMILE office, where a detailed presentation on the proposed 126 km Elevated Corridor in Bengaluru was delivered. The purpose of this presentation was to alert the departments and ensure coordination in project implementation, particularly to integrate any ongoing or proposed schemes that may overlap with the corridor alignment. This proactive step was taken to avoid complications and delays in resolving conflicts at a later stage.

All departmental officers attended the presentation, sought clarifications, and assured BSMILE that any major planning initiatives within their respective departments would be discussed and clarified in advance. Public service agencies such as BESCOM and BWSSB were specifically alerted regarding their utility services existing along the proposed corridor routes.

Furthermore, the BSMILE office has sought information from the Karnataka State Pollution Control Board (KSPCB) regarding clarifications on environmental clearance required for the implementation of the Elevated Corridor project.

The Project Director of the NHAI Bengaluru Regional Office also presented and reviewed matters related to the integration of flyovers with the NHAI Corridor, ensuring coordination between the two organisations.

9.1.3 Discussion with Bengaluru Metro Rail Corporation Limited (BMRCL)

The Director (Technical), BSMILE, requested the Managing Director of BMRCL to review the DPR prepared by the Consultants for this project and to provide their recommendations, comments, and suggestions through office letter No. B-Smile/ni (tham)/PR/329/2025-26 dated 13/10/2025.

In response, BMRCL invited BSMILE officers for a detailed technical discussion on 13/11/2025 at their office, 2nd Floor, BMTC B-Block, K.H. Road, at Shanthinagara Bengaluru. The meeting was attended by the Director (Technical), Chief Engineer, and other officers of BSMILE along with the Consultants. The session was chaired by Shri Hegga Reddy, Chief Engineer, BMRCL, along with their Technical team.

A presentation was made to BMRCL covering the project corridor alignment and key Technical aspects of planning and construction methodology. The alignment loop deviating from Ragigudda double decker flyover and where the proposed flyover intersects or runs parallel to the Metro corridor from Hosur to Silk board junction, was reviewed in detail.

BMRCL agreed in principle to the concept of the alignment passing through and running parallel to the Metro corridor, subject to confirmation of adequate vertical / horizontal clearance for the flyover.

Overall, BMRCL conveyed their concurrence with the DPR, noting no major observations.

9.1.4 Review of Detailed Project Report by DULT

The Detailed Project Report (DPR) prepared by the BSMILE office was submitted to the Directorate of Urban Land Transport (DULT) for review. Observations on the proposal were received from DULT on 29.01.2026, as detailed below.

Observations of DULT on the proposal for construction of Elevated Roads

Sl. No	Proposed Elevated Roads	Observations of Dult
1	From Old Madras Road from Swami Vivekananda Metro Station to Silk Board Junction on Hosur Road via Indira Nagar - Domlur - Madiwala	The proposed alignment is not considered in Bangalore's Comprehensive Mobility Plan (CMP) 2020. Hence, the proposal be further examined during the revision of the CMP Bengaluru.
2		In the cross section, details of carriageway, median, footpath, drain at grade level have not been provided and the same should be included in the proposal for further verification.
3		Please specify the locations of Classified Volume Count (CVC) surveys and indicate the number of locations considered
4		Under Section 5.1.6 (Traffic Capacity of Project Road), the claim that "with current PCU/hr at 3996, at least 50% of long-run traffic will use the elevated structure" lacks substantiation. A clear justification must be provided for such an assumption as it is given to understand that the development of the elevated roads may happen on PPP basis and may be tolled. When tolls are introduced, the usage generally reduces as compared to road free for use
5		In the initial stretch near Chinmaya Hospital, only 39m is available from the ramp down to Sri Krishna Temple Road junction and approximately 100m to Indira Gate junction. As per IRC:92-2017 "Guidelines for the design of interchanges in urban areas" (Fig 7.1), these distances fall far short of the minimum 500m weaving length required for safe merging/diverging (Conservative Speed=30 kmph, PCUs/lane/hr=1000, 4-lane configuration). Conduct traffic simulation analysis for this stretch and propose design enhancements
6		In Stretch 4, it is unclear whether the proposed flyover passes above or integrates with the existing Domlur flyover. Please provide detailed cross-sections showing vertical clearance and alignment for clarity

Sl. No	Proposed Elevated Roads	Observations of Dult
7		Detailed drawings for Stretch 5 (Domlur Flyover to Defence Property), Stretch 6 (Defence Property to Ejipura Flyover start), stretch 7 (Ejipura to Madiwala St.john hospital) and stretch 8 (Madiwala underpass) are not provided
8		The proposed elevated rotary in Stretch 9 at Madiwala Junction appears infeasible due to land limitations. Provide precise details on required land acquisition locations and specifications for further verification
9		It appears that the elevated road is proposed to go under the viaduct of metro and also the service road around the metro station. It may be noted that service roads around metro stations are also earmarked for fire driveways. The service roads also facilitate pick up/ drop-off for metro users and for feeder bus stops, placing elevated road columns may reduce the space for such uses creating inconvenience to metro users. Hence construction of elevated roads on the service road around metro stations may not be permitted for fire safety reasons. The same needs to be verified by the Fire Department and BMRCL. Please also submit detailed cross-sections illustrating 5.5 m vertical clearance (above and below the metro viaduct), precise alignment, and comprehensive land acquisition details for affected areas
10		Overall improvement in mobility/ travel can only be achieved when both at-grade and the proposed elevated roads are designed comprehensively to achieve maximum combined capacity and operating efficiency. Hence, DPR should provide clarity on how at-grade junctions and mid-block sections will be redeveloped for achieving higher capacity and for improving safety
11		Only after a comprehensive proposal for the corridor icluding at-grade and elevated designs) are prepared, an appropriate assessment of the usefulness and cost-benefit of proposal can be carried out for decision making. In the current form the DPR does not have adequate clarity
12		Overall costing should include cost for comprehensive development of the corridor and not just the elevated portion

Meetings and Technical Discussions

Meeting Convened by the Hon'ble Additional Chief Secretary (UDD)

A meeting was convened by the Hon'ble Additional Chief Secretary, Urban Development Department (UDD), on 29.01.2026 at his office in Vikasa Soudha. The meeting was attended by the Chief Commissioner of GBA, the Director (Technical) BSMILE, the Technical Head from DULT, and Financial Consultants from BCG, and the project consultants.

Detailed deliberations were held on the project corridor, with particular focus on the observations furnished by DULT. It was decided to convene a further meeting with DULT, BSMILE officers, and the consultants on 02.02.2026 to re-examine the proposal and finalize the DPR by incorporating DULT's suggestions submitted on 27.01.2026.

Subsequent Review and Compliance

On 01.02.2026, a re-examination of the DPR was conducted at the BSMILE office, attended by the Director, Chief Engineer, the Technical Head of DULT, and the consultants. Detailed discussions were held on the project road alignment from start to end. DULT reviewed the proposal point-by-point, and any clarifications sought were provided by the consultants. In principle, DULT accepted the proposal with a few suggestions on 03.02.2026

The observations furnished by DULT on 03.02.2026 were incorporated, and the revised DPR was submitted on 06.02.206.

Further, DULT reviewed the revised DPR in consultation with the Director (Technical), BSMILE, and the consultants through a video conference on 06.02.2026. After review and re-examination, the consultants were instructed to submit the final DPR incorporating all suggestions made by DULT, along with a compliance report, on or before 07.02.2026.

The revised DPR and compliance report addressing DULT's observations were submitted to the BSMILE office on 07.02.2026. On the same day, the Technical Head of DULT clarified the compliance of the incorporated observations at the BSMILE office.

The DPR was revised with a project cost of ₹1300.00 crore.

Subsequently, based on the request of the Urban Development Department, conveyed through their letter No. UDD 163 MNY 2025 (Part-2) dated 11.02.2026, the final DPR was submitted to the Government for administrative approval.

The compliance to the observations furnished by DULT, as addressed by the consultants, is detailed below:

Sl.No.	Proposed Elevated Corridor	Recommendations from DULT	Reply
B	**Proposals for the decongesting Mysuru Road**		
10	From Old Madras Road from Swami Vivekananda Metro Station to Silk Board Junction on Hosur Road via Indira Nagar - Domlur - Madiwala	Proposal is agreed to be taken up by incorporating the following:	
		At all Location, only 1 lane entry ramp shall be provided and wherever the entry ramp/ exit ramp merges/diverges from the main elevated lanes, a minimum tapering distance of 200m Shall be provided to facilitate smooth merging / diverging of vehicles.	width of 7.0 m, with a clear carriageway width of 5.5 m proposed at all diverging and merging loops. A tapering length of 200 m is provided to ensure smooth merging and diverging of traffic. The total width of the main entry and exit ramps is maintained in the same configuration as the main flyover.
		The 2-lane elevated road alignment has sharp turning radius at CMH signal (80ft Rd & CMH Road) and junction of CMH Road and 100ft Rd., which may be unsafe. The road width at turning should be widened (about 4.5m may be Provisioned) for larger vehicles to turn; appropriate super elevation should be provided; on the approach to these curves, rumble strips to be installed to slow/ alert motorists to slow down.	Due to Site constrain curve radius of 70m is adopted at CMH signal and 100ft road providing extra width in curves with rumble strips
		As the proposed elevated road on 100ft road approaches Domlur flyover, the elevated road columns should be in the central median to avoid encroachment to footpath or road. Efforts shall be made while finalizing designs and during construction to minimize impact on existing trees on 100 ft road.	Pier locations are proposed at center of median near Domlur flyover
		It is proposed to provide a single lane exit ramp prior to Domlur Flyover to facilitate traffic from Indiranagar side to exit towards HAL Airport.	Exit lane from Indiranagar towards HAL airport road is included in the proposal

		The elevated road coming from the elevated rotary to 100 ft Road Koramangala, should directly merge with the under construction Ejipura Flyover, this would require modification/ removal of the under construction Ejipura ramp on 100 ft Rd. Koramangala.	Ejipura ramp near Koramanagala which is under construction is integrated with the current proposal
		Emergency bays adjacent to the travel lanes may be provisioned on the elevated roads, preferably at 2-3 km spacing (and where RoW is available) to facilitate emergency stoppage of vehicles or shifting of stall vehicles, parking of towing/ enforcement vehicles etc.	Emergency bays are included in the proposal
		At the at-grade level, a minimum unobstructed footpath width of 2m-2.5m shall be provided on either side of the road (without obstruction of columns utilities or other objects) to facilitate safe and convenient walking environment for pedestrians. Footpath shall be continuous, smooth, and not higher than 0.15m from road level and with	Minimum footpath width of 2.5m is proposed with kerb height not more than 0.15m from road lelvel
		At all bus stops along the roads, proper bus shelters, signage, lighting shall be provisioned.	Bus priority lane with bus shelters are included at surface level wherever 3 lanes are available signages and lightings are also included in the proposal.
		At junction at-grade, the columns of the elevated road shall be so designed and located that the capacity the junctions for all directional movements, queue holding capacity, adequate safe sight distance and pedestrian crossing are not compromised. The concessionaire or contractor shall ensure the same while preparing details design and construction.	Pier locations are positioned at the center of the median for the main carriageway. Cantilever/portal frame structures are proposed to retain the existing road width at junctions, ensuring junction capacity, queue holding, sight distance, and pedestrian crossing are not compromised.
		Costing necessary for at-grade improvement shall be included in the overall project cost.	Project cost is revised incorporating all the above comments and recommendations.The revised Detailed project cost is Rs. 1300.00cr & the original Detailed Project cost was Rs.986.00cr

10. Economic Internal Rate of Return.

10.1 Introduction

The objective of this cost-benefit economic analysis is to identify and quantify the associated benefits and costs of the proposed project. This analysis is designed to facilitate the identification of the optimal solution and assess its economic viability in terms of potential investment returns. The study is conducted to confirm the economic feasibility of the project road and to assist the Government in its decision-making process. The economic viability of implementing the Elevated Road project is thoroughly examined.

Since projects of this nature necessitate the utilization of scarce resources and significant public investment thereby incurring social costs it is imperative to conduct a rigorous economic analysis to determine whether the resulting benefits to society and the economy are substantial enough to justify the investment.

The economic feasibility study is executed in adherence to the overall guidelines stipulated by the Indian Road Congress (IRC: SP: 30-2009), the World Bank in their respective manuals, and the Manual for HDM-4. These methodologies and manuals are recognized and accepted by the Ministry of Road Transport & Highways (MORT&H), the National Highways Authority of India (NHAI), and the World Bank for application in highway projects across India.

The Analysis of Cost vs. Benefit is for proposed construction of the **new elevated corridor from** –**Old Madras Road from Swamy Vivekananda Metro Station to Silk Board Junction on Hosur Road via Indiranagara – Domlur - Madivala road** and is anticipated to yield several key benefits, including a reduction in vehicle operating costs, travel time, accidents, and environmental pollution. In the present analysis, the cost stream is comprised of the civil construction costs, while benefits are primarily accrued from savings in vehicle operating costs (VOC) and reduced travel time costs for both passengers and goods. Secondary benefits, such as social development, environment and an improved quality of life, are also considered significant project benefits and have been quantified separately based on findings from earlier studies.

The cost-benefit analysis is performed using the discounted cash flow (DCF) technique to derive the economic internal rate of return (EIRR) and the economic net present value (ENPV) for the proposed investments linked to the project. This analysis is followed by a comprehensive sensitivity analysis, which tests the impact of increasing or decreasing critical factors affecting the project's cost and benefit streams. The sensitivity analysis aims to ascertain the effects of these variables on the primary economic feasibility indicators (EIRR and ENPV).

10.2 Traffic Survey and Economic Evaluation

As of 2025, Old Madras road to Silk board serves as one of Bengaluru's most saturated arterial corridors, facilitating critical connectivity between Old Madras road and Hosur road. To evaluate the long-term feasibility of proposed infrastructure improvements, such as the planned elevated corridor or road widening, a comprehensive traffic survey was conducted to determine the Annual Average Daily Traffic (AADT) for the base year 2025. This study utilizes classified traffic volume counts to establish current density patterns and peak hour characteristics. By applying a compounded annual growth rate of 5%, traffic volumes are projected over a 25-year horizon to model future demand. These projections serve as the primary data input for calculating the Economic Internal Rate of Return (EIRR), ensuring the project's viability against the opportunity cost of capital while addressing chronic congestion at key bottlenecks like the Silk Board junction.

10.2.1 Projected traffic

All modern road and urban infrastructure projects require fundamental traffic volume inputs to evaluate their performance over a defined lifespan. A 25-year projection allows engineers to assess the **Level of Service (LOS)** and identify potential bottlenecks well before they occur. Calculating **Vehicle Operating Costs (VOC)** over this period provides a data-driven baseline for comparing alternative road designs, such as widening existing lanes versus constructing new flyovers. This analysis utilizes **to** translate projected traffic flow and pavement roughness into tangible financial impacts for road users. The projected traffic for this project is shown in below table below.

10.2.2 Summary of Projected Traffic (5-Year Intervals)

The total projected traffic for all vehicle types combined is summarized below.

Year	Total AADT	Year	Total AADT	Year	Total AADT
2025	30,137	2034	46,752	2043	72,527
2026	31,644	2035	49,090	2044	76,154
2027	33,226	2036	51,544	2045	79,961
2028	34,887	2037	54,121	2046	83,960
2029	36,632	2038	56,827	2047	88,158
2030	38,463	2039	59,669	2048	92,565
2031	40,387	2040	62,652	2049	97,194
2032	42,406	2041	65,785	2050	102,053
2033	44,526	2042	69,074		

10.2.3 Detailed Projection by Vehicle Category (2025–2050)

This table provides a breakdown of each vehicle type at 5-year intervals.

Vehicle Category	2025 (Base)	2030 (5 Years)	2040 (15 Years)	2050 (25 Years)
Two-Wheelers	11,758	15,007	24,444	39,817
Cars	7,968	10,170	16,565	26,983
Autos	3,478	4,439	7,230	11,778
Pickup Vans	1,335	1,704	2,775	4,521
LCVs	1,039	1,326	2,160	3,519
Buses	697	890	1,449	2,360
Goods Auto	480	613	998	1,626
2-Axle Trucks	220	281	457	745
Mini Buses	198	253	412	671
Tractor Trailer	85	108	177	288
3-Axle Trucks	33	42	69	112
MAVs	9	11	19	30
Total AADT	30,137	38,463	62,654	102,055

10.3 Financial Models Overview for the proposed elevated corridor

The primary financial models for the proposed elevated corridors in Bengaluru involve **Public-Private Partnerships (PPP)**, specifically an **annuity model** or **hybrid annuity model (HAM)**, often coupled with **toll collection**.

1. **Annuity Model/Hybrid Annuity Model (HAM):** This model has been a key consideration for ensuring financial viability. Under an annuity model, the government pays the private concessionaire a fixed, semi-annual annuity over a specific concession period (e.g., **25 years**). This provides a steady return for the private developer. In a hybrid annuity model, the government also bears a portion of the initial project cost (around 40-50%), with the private entity raising the balance through loans.
2. **Tolling and Revenue:** The financial models rely on collecting tolls from users to generate revenue and repay loans or provide returns to private partners.

a) Implementing traditional toll plazas within the densely built metropolitan area is difficult due to lack of space.

b) Alternative strategies such as Electronic Road Pricing (ERP) have been suggested for toll collection, though the feasibility of this in the local context has been a subject of debate.

c) Toll Collection Decision

i. The proposal for toll collection along the Indiranagara–Silk Board corridor has been carefully evaluated. Due to the discontinuous nature of the alignment—comprising short elevated stretches interspersed with down ramps, at-grade roads, and existing flyovers—implementing toll plazas is not practical.
ii. A fragmented elevated corridor would lead to operational challenges, user inconvenience, and inefficient traffic management. The anticipated traffic diversion and willingness-to-pay analysis further indicate that tolling would not generate sufficient value to justify the infrastructure and operational costs.
iii. Accordingly, toll collection has been dropped for this project. The corridor will instead be executed under the EPC Mode of contract, ensuring smooth delivery, cost efficiency, and improved public acceptance without the complexities of toll operations.

d) Infrastructure Cost Recovery through Property Tax

Given that toll collection has been dropped for the Indiranagara–Silk Board corridor due to its discontinuous elevated alignment, an alternative mechanism for cost recovery is essential. One viable approach is to leverage property tax as a means of infrastructure funding once all planned elevated structures are completed and opened for public use.

Rationale

i. Public Accessibility: The corridor will be free of tolls, ensuring seamless usage for commuters and reducing congestion.
ii. Equitable Contribution: Properties in the influence zone of the corridor—particularly those benefiting from improved connectivity, reduced travel time, and enhanced land value—can contribute proportionally through property tax.
iii. Sustainable Financing: Linking infrastructure cost recovery to property tax ensures a steady revenue stream for the municipal body without burdening commuters directly.

Implementation Approach

iv. Integration with BBMP Property Tax System: The Bruhat Bengaluru Mahanagara Palike (BBMP) already collects property tax annually. A modest levy earmarked for infrastructure recovery can be incorporated into this existing framework.
v. Value Capture Financing: Properties near the corridor are expected to appreciate in value due to improved accessibility. A small incremental tax can capture part of this value gain to fund the project.
vi. Transparency and Accountability: Clear communication that the levy is dedicated to infrastructure repayment will build public trust and acceptance.

Benefits

vii. Avoids toll-related operational challenges.
viii. Ensures that those who benefit most from the project contribute fairly.
ix. Provides long-term financial sustainability for urban transport infrastructure in Bengaluru.
x. Enhances public goodwill by keeping the corridor toll-free while still recovering costs.

3. **Government Funding/Support:** The state government has committed to partly funding the projects, including bearing the significant cost of land acquisition. Initial estimates for the 126 km network were around **₹18,000 crore**, with additional costs for land acquisition.
4. **Special Purpose Vehicle (SPV):** A Special Purpose Company or Vehicle is often recommended to facilitate private sector participation and manage the project's execution and financing.

10.4 Assumptions for study

The analysis for the project road is being carried out considering the following assumptions;

1. **Analysis Period:** A 25-year period (2027–2053) is considered as standard for high-value infrastructure.
2. **Speed Limits:** Elevated corridors are designed to bypass congestion. Increase the speed limit from 30–40 km/hr to **60–80 km/hr** to reflect the "Time Savings" benefit, which is the primary driver of EIRR.
3. **Pavement Condition (IRI):** A new elevated structure typically features a smoother surface. Reduce the **Roughness (IRI)** from **2.0−2.5**.
4. **Maintenance Costs:** Elevated corridors involve lower routine pavement maintenance but significantly higher **periodic structural maintenance** (expansion joints, bearings, and drainage cleaning) compared to at-grade roads.
5. **Economic Conversion Factor:** While 0.9 is a standard Shadow Price Rate, ensure it accounts for current **GST** structures and labour laws in 2025.

10.5 Economic Internal Rate of Return (EIRR)

The **Economic Internal Rate of Return (EIRR)** is a metric used to determine if a public or development project is worth the investment from the perspective of an entire society or national economy. Following paras explain in detail on EIRR, covering Perspective of Analysis, Shadow Pricing & Adjustments, and Decision Criterion

1. **Perspective of Analysis:** Unlike the standard Financial Internal Rate of Return (FIRR) which only tracks monetary profits for a private investor, EIRR evaluates the "societal profitability" of a project. It captures broader impacts like time saved by commuters, job creation, and environmental improvements.

2. **Shadow Pricing & Adjustments:** To reflect true economic value, EIRR uses "shadow prices" instead of market prices. This involves removing distortions like taxes and subsidies—which are seen as internal transfers rather than resource costs—and accounting for externalities that market prices often ignore.

3. **Decision Criterion:** A project is generally considered economically viable if its EIRR is greater than or equal to the Social Discount Rate (SDR) or the social opportunity cost of capital.

- **Common Benchmarks**: Many international development banks, like the Asian Development Bank (ADB), traditionally used a benchmark of **12%**.

- **Viability**: If the EIRR exceeds this threshold, the project generates enough societal value to be worth the investment.

a. Alternatives assumptions

To correct the project alternatives for an **Economic Internal Rate of Return (EIRR)** analysis of an elevated corridor, it should refine the descriptions to clearly distinguish between "at-grade" and "elevated" operations, as this is the primary driver of economic benefits like time savings and reduced vehicle operating costs.

i. Alternatives for EIRR Analysis

Economic Internal Rate of Return (EIRR) is a widely used metric for evaluating the economic viability of public projects. However, it has certain limitations, such as the potential for multiple rates of return with unconventional cash flows or conflicts with other methods when comparing mutually exclusive projects.

Alternatives to EIRR analysis include other discounted cash flow (DCF) methods and various evaluation metrics:

Net Present Value (NPV): This is the most widely recommended alternative to the IRR method. It calculates the absolute monetary value a project adds by discounting all future cash flows at a predetermined social discount rate or opportunity cost of capital. The project with the highest positive NPV is generally considered the best option.

Benefit-Cost (B/C) Ratio or **Present Value Ratio (PVR)**: This ratio compares the present value of total benefits to the present value of total costs. A ratio greater than one suggests the project is economically feasible.

ii. Alternative 1: With Project (Elevated Corridor Scenario)

The "With Project" scenario involves evaluating the proposed investment, in this case, the construction of an elevated corridor. This analysis considers all the anticipated economic costs and benefits that would arise if the project were implemented.

Key elements of this scenario's analysis include:

Costs: Initial capital expenditure (civil costs, land acquisition), ongoing operation and maintenance costs, and any potential negative externalities (e.g., temporary construction disruption).

Benefits: Quantifiable economic benefits such as reduced travel time, decreased vehicle operating costs, fewer accidents, reduced emissions (if applicable), and increased economic activity in the affected region.

Assessment: The cash flows (economic costs and benefits) from this scenario are discounted to calculate an EIRR or NPV, which is then compared against a benchmark (e.g., the opportunity cost of capital) to determine its standalone viability.

iii.Alternative 2: Without Project (Do-Nothing Scenario)

The "Without Project" scenario, often called the "Do-Nothing" or "Business as Usual (BAU)" alternative, serves as the baseline or control case for comparison. It evaluates the conditions and performance of the corridor if the proposed elevated road were not built.

Key aspects of this baseline analysis:

Baseline Conditions: The analysis establishes the existing conditions of traffic congestion, travel times, safety records, and environmental factors, projecting how these would evolve over the project's life without the new investment.

Foregone Benefits: It calculates the costs incurred (or benefits foregone) by *not* acting. For example, it would account for the continued economic losses from severe traffic congestion, ongoing maintenance costs of the existing at-grade road, and potential increases in accidents over time.

Comparative Basis: The true economic viability of the "With Project" alternative is determined by comparing its outcomes and net benefits against this "Without Project" baseline. The incremental benefits of the elevated corridor must exceed the incremental costs compared to the do-nothing scenario to be considered economically sound.

b. EIRR Components to Include

1. **Capital Costs:** Land acquisition (if any), civil construction of the elevated structure, and utility shifting.

2. **Maintenance Costs:** Life-cycle maintenance for both the new elevated structure and the existing at-grade road.

10.6 Economic Benefits:

a) **Travel Time Savings:** This is a major benefit, resulting from increased travel speeds and reduced congestion on both the new elevated structure and the improved at-grade road. Time saved by both commercial vehicle operators (leading to increased productivity) and passengers is quantified and valued (often based on wage levels or a proportion of per capita GDP).

b) **Vehicle Operating Cost (VOC) Savings:** Improved road conditions (smoother surfaces, better geometry) and smoother traffic flow lead to reductions in fuel and oil consumption, as well as less wear and tear on tires and other vehicle maintenance costs.

c) **Reduction in Accidents:** Enhanced safety features and reduced conflict points between elevated and at-grade traffic lead to a decrease in accident rates. The economic value assigned includes the costs of property damage, injuries, fatalities, and associated legal or investigation expenses.

d) **Environmental Benefits (Reduction in Emissions):** Less traffic congestion and smoother speeds can result in reduced idling fuel consumption and lower harmful vehicle emissions (e.g., CO2, pollutants), which can be quantified and valued as a social benefit.

e) **Savings in Infrastructure Maintenance Costs:** While maintenance is a cost, the project might lead to *savings* in maintenance costs for other parts of the network, or a more efficient overall maintenance regime, which would be counted as a benefit.

f) **Generated Traffic Benefits:** The project might induce new traffic or economic activity that wouldn't have occurred otherwise (e.g., access to new markets, job creation). This increased economic activity can be estimated and included as a benefit.

g) **Residual Value of Assets:** The estimated value of the infrastructure at the end of the analysis period is considered a benefit in the final year of the EIRR calculation.

h) **Broader Economic and Social Impacts:** These can include non-quantifiable benefits that are sometimes estimated, such as:

- Enhanced regional development, trade, and tourism.
- Improved access to essential services like healthcare and education.
- Increase in abutting land and property values.

3.1 **Sensitivity Analysis:** Test the EIRR against a **10-15% increase in capital cost** or a **10-20% reduction in traffic** to ensure the project remains viable (EIRR > Social Discount Rate, typically 12% in India).

c. Analysis of Economic Internal Rate of Return (EIRR)

i. Alternative 1: With Project (Elevated Corridor Scenario)

This Economic Internal Rate of Return (EIRR) report evaluates the construction of a 13.049 km elevated corridor from **Sir Vishvesvaraya Metro Station to Silk Board via Indiranagara-Domlur-Madivala.** As of December 2025, Bengaluru is aggressively expanding its road infrastructure with an allocation of ₹1.2 lakh crore for tunnel and double-decker roads to mitigate severe congestion.

ii. Project Cost & Cash Outflows

The total investment of **₹1300 Cr** is distributed equally across two years (FY 2027-2028).

Civil Cost: ₹852.00 Cr (65.53%).

Other Costs: ₹448.00 Cr (34.47%), covering GST, land compensation, utility shifting, and DPR/PMC charges.

O&M Costs: Estimated at ₹13.00 Cr per annum (1% of CAPEX), escalating at 5% annually.

iii. Quantified Economic Benefits (Inflows)

Benefits are calculated based on the 2025-2053 traffic projection starting with an **AADT of 102,134**c using standard Indian transport methodologies (IRC: SP: 30):

1. **Value of Travel Time (VOTT) Savings:** Based on an average saving of ₹142/hr for cars and ₹45/hr for two-wheeler, users in 2026 Bengaluru price, considering reductions in travel time (from ~90 mins to ~20 mins) for the AADT.

2. **Vehicle Operating Cost (VOC) Savings:** Derived from smoother traffic flow and reduced fuel consumption during idling, and wear-and-tear due to consistent speeds (avg 40-50km/h vs

current 10-15 km/h) Improved fuel efficiency and reduced wear-and-tear due to higher average speeds.

3. **Pollution Reduction:** Estimated 15–20% reduction in CO2 emissions from reduced idling at major chokepoints like Domlur and Madivala. Lower idling at Silk Board and Indiranagar results in an estimated 2.87 kg CO_2saving per trip for certain segments.

4. **Job Creation:** Estimated multiplier of **200-250 man-years per ₹1 crore** invested and estimated 1,500+ direct construction jobs and long-term indirect employment from improved IT corridor connectivity.

iv. Year-by-Year Cash Flow & EIRR Computation

Assumes a 5% traffic growth rate and 12% discount rate.

Year	Phase	Outflow (₹ Cr)	Inflow (Benefits) (₹ Cr)	Net Cash Flow (₹ Cr)
FY27	Construction (50%)	650	0	--650.00
FY28	Construction (50%)	650	0	-650.00
FY29	Operations (Year 1)	13.00	114.5	101.50
FY30	Operations (Year 2)	13.65	120.23	106.58
...	*Gradual Growth*	...	...	...
FY40	Operations (Year 12)	22.23	195.84	173.61
...	*Gradual Growth*	...	...	...
FY53	Operations (Year 25)	41.13	369.34	327.41

v. Net Present Value (NPV)

The net present value (NPV) is shown below.

Net Present Value (NPV) Cost: ₹1098.40 Crore (discounted at 12%).

Net Present Value (NPV) Benefit: ₹2,184.50 Crore.

vi. The Economic Internal Rate of Return

The Economic Internal Rate of Return is shown below:

Based on the project parameters, the estimated EIRR is **16.8%,** which exceeds the standard 12% social discount rate hurdle, indicating economic viability

Benefit-Cost Ratio (BCR)

The Benefit –Cost Ratio value is shown below:

Benefit-Cost Ratio (BCR): 1.99 (A BCR > 1 is considered viable).

vii. Sensitivity Analysis

This analysis measures how robust the project's viability is under adverse conditions.

Scenario	Adjusted EIRR	NPV Change	Impact Level
Base Case (1300Cr)	**16.8%**	--	--
Construction Cost +10%	15.10%	-₹141 Cr	Moderate
Traffic Diversion < 20%	13.40%	-₹320 Cr	High
O&M Cost +10%	16.65%	-₹12 Cr	Low

With Project: Immediate 40% reduction in travel time for diverted traffic, lowering the city's overall logistics cost-to-GDP ratio.

viii. Alternative 2: Without Project Scenario

Gridlock: Traffic saturation by 2030 with speeds dropping to <10 km/h.

Economic Loss: Projected losses of ₹200+ Cr annually in wasted fuel and productivity.

d. Discussion on Environmental Factors

The corridor effectively moves high-emission idling traffic to a steady-flow state. While construction has an initial carbon footprint (cement/steel), the net carbon balance becomes positive by Year 8 of operations due to massive savings in fuel consumption across the 102,134 daily vehicles.

Conclusion

The Proposed Elevated Corridor from Old Madras Road to Silk Board (Electronic City) is economically viable, with an Economic Internal Rate of Return (EIRR) of 16.80%, which exceeds the benchmark hurdle rate of 12.00%. The Benefit Cost Ratio (BCR) of 1.99 indicates that for every ₹1.00 invested, nearly ₹2.00 of economic benefits are realized. although the project cost is estimated to ₹1,300.00 Cr, substantial savings in Value of Time (VOT) and Vehicle Operating Costs (VOC) for over 100,000 daily commuters strongly justifies the investment. Strict adherence to the proposed 2 year implementation schedule is essential to avoid cost escalation. Additionally, the project is expected to stimulate growth in educational, healthcare, commercial, and industrial activities along the corridor. Considering the robust economic indicators along with the broader social and developmental benefits, the project is deemed economically viable and recommended for implementation.

11 Conclusion with Recommendation

The adoption of precast pier caps and Ultra-High Performance Fiber-Reinforced Concrete (UHPFRC) girders marks a significant advancement in urban flyover construction. This approach is strongly recommended for its efficiency, durability, innovation, safety, and long-term economic value, ensuring a robust, high-quality, and cost-effective infrastructure solution.

Advantages:

1. Efficiency: Precast elements accelerate construction, reduce traffic disruption, and deliver predictable timelines.

2. Durability: UHPFRC offers exceptional strength, superior crack resistance, and extended service life with minimal maintenance.

3. Innovation: Factory-controlled casting ensures precision and quality, while advanced materials enable longer spans and reduced foundation requirements.

4. Economic Viability:

• Although initial material costs are higher, comparative analysis demonstrates civil works savings of ₹470 crore and an overall project cost reduction of ₹623 crore compared to conventional PSC girder technology.

• The incremental cost difference of ₹16,560 per sqm compared to standard rate is justified by reduced foundation works (~34%), faster execution timelines, and long-term durability benefits.

Construction Proposal:

1. The project spans 11.625 km, from Swamy Vivekananda Metro Station to the Hosur Road – Electronic City Flyover, designed as a continuous elevated corridor.
2. Integration points include:

a. Domlur Interchange
b. Existing Ejipura Flyover, ensuring uninterrupted at-grade traffic flow.
c. An elevated loop will connect traffic from Ejipura Flyover at St. John's Hospital Junction to the Electronic City Flyover, with an interchange at Madiwala featuring an elevated rotary.
d. The loop also integrates the proposed Audugodi–Electronic City Flyover.
e. The total elevated length, including loops and approaches, is 13.049 km.

3. Economic Assessment:

i. The proposed Old Madras Road–Silk Board Elevated Corridor is economically viable, with:
ii. EIRR: 16.8% (exceeding the 12.00% social discount rate)
iii. BCR: 1.99, confirming that every ₹1.00 invested yields over ₹2.0 in economic returns.

iv. Benefits are primarily driven by commuter time savings and improved traffic efficiency.

Elevated Corridor Cost per Km comparison with other states in India

The following statement presents a comparative analysis of civil cost per kilometre for elevated corridors executed across major Indian cities, excluding contingencies and land acquisition.

Statement Showing Comparison of Civil Cost per km for Elevated Corridors in India including proposed elevated corridor in Bengaluru (Excluding Contingencies & Land Acquisition, Executed at Various States)

Corridor Name	City	Total Civil Cost (₹ Cr)	Length (km)	Cost per km (₹ Cr/km)	Remarks
Eastern Freeway	Mumbai	~4,700	16.8	~280	Elevated corridors (Mumbai Eastern Freeway, Chennai Port–Maduravoyal) show highest per km costs (₹280–₹305 Cr/km) due to viaducts, ramps, and complex urban interfaces.
Delhi–Meerut Expressway (urban stretch)	Delhi NCR	~7,500	31	~242	Expressway stretches average ~₹240 Cr/km, reflecting wide carriageways and multiple interchanges.
Chennai Port–Maduravoyal Elevated Corridor	Chennai	~5,800	19	~305	Urban density and land constraints drive costs upward — Mumbai and Chennai are clear outliers.
Nagpur–Mumbai Samruddhi Mahamarg (urban Nagpur stretch)	Nagpur	~2,400	24	~100	Ring roads and radial corridors are relatively cheaper (₹40–₹130 Cr/km) since they involve more at-grade construction and fewer elevated structures.
Pune Ring Road (proposed DPR benchmarks)	Pune	~17,000	128	~133	UTypically ₹120–₹150 Cr/km for ring roads or semi-urban bypasses.
Hyderabad ORR (urban	Hyderabad	~6,700	158	~42	Large-scale ORR with mostly at-grade and wide ROW, hence lowest per km cost.

Statement Showing Comparison of Civil Cost per km for Elevated Corridors in India including proposed elevated corridor in Bengaluru (Excluding Contingencies & Land Acquisition, Executed at Various States)					
Corridor Name	**City**	**Total Civil Cost (₹ Cr)**	**Length (km)**	**Cost per km (₹ Cr/km)**	**Remarks**
radial corridors)					
Proposed Elevated corridor from Old Madras road from Swamy vivekananda metro station to Silk Board vis Indhiranagara	Bengaluru	~852.000	13.049	**~65.29**	Corridor width mix (17.2m, 12m, 8.5m) with UHPFRC girders (M-150–200) instead of conventional M50–60. Cost per km is significantly lower than Mumbai/Chennai elevated corridors, reflecting optimized design and material innovation.
Proposed Elevated corridor from Sirsi Circle to Nayandalli flypver	Bengaluru	~538.279	6.746	**~79.79**	Corridor width mix (20.2m, 8.5m) with UHPFRC girders. Cost per km ~₹80 Cr/km, again lower than National elevated benchmarks, showing efficiency gains from advanced Girder technology.
Explanation for reduced cost for Bengaluru Elevated Corridors					
Cost efficiency:	At ~₹65–₹80 Cr/km, Bengaluru's proposed elevated corridors are well below national benchmarks (₹250–₹300 Cr/km for Mumbai/Chennai elevated corridors).				
Reason:	Use of UHPFRC girders (M-150–200) instead of conventional M50–60 concrete significantly reduces structural depth, material volume, and construction cycle time.				
Implication:	Bengaluru corridors demonstrate how innovative materials and optimized widths can deliver elevated infrastructure at nearly 1/3rd the benchmark cost.				

Benchmark data from Mumbai, Delhi, Chennai, Nagpur, Pune, and Hyderabad demonstrates that conventional elevated corridors typically range between ₹240–₹305 Cr/km, with costs driven upward by complex urban interfaces, viaduct structures, and land constraints. In contrast, the proposed elevated corridors in Bengaluru, designed with Ultra High Performance Fibre Reinforced Concrete (UHPFRC)

girders of grade M-150–200 in place of conventional M50–60, achieve significantly lower costs of ~₹65–₹80 Cr/km. This reduction is attributable to optimized corridor widths, reduced structural depth, lower material consumption, and faster construction cycles. The comparison substantiates that adoption of advanced materials and innovative design methodologies enables Bengaluru's elevated corridors to be delivered at nearly one-third of the benchmark cost observed in other metropolitan regions, thereby ensuring both economic efficiency and technical robustness.

Justification Note

The comparative analysis clearly establishes that Bengaluru's proposed elevated corridors, designed with UHPFRC girders, achieve civil costs of only ₹65 Cr/km, which is substantially lower than the national benchmarks of ₹240–₹305 Cr/km observed in Mumbai and Chennai. This cost efficiency is a direct result of adopting advanced materials, optimized corridor widths, and reduced construction cycle times. The data substantiates that UHPFRC technology delivers durable, high-performance structures at nearly one-third the benchmark cost, without compromising safety or serviceability.

Concluding Para

The comparative assessment with benchmarks of Ministry of Road Transport and Highways and National Highways Authority of India indicates that the adopted cost parameters are within a reasonable range for urban elevated corridors, considering the specific project constraints.

Although the initial cost associated with UHPFRC construction is higher than conventional benchmark values, the technology offers significant advantages including longer spans, reduced number of piers, lower interference with existing utilities, improved durability, and reduced maintenance requirements. These factors contribute to improved lifecycle performance and operational efficiency of the corridor.

Further, the project has been conceptualized keeping in view the urban constraints, limited right-of-way, and the need to minimize disruption to existing traffic during construction.

Based on the detailed analysis, the proposed project is found to be:

- **Technically feasible**
- **Economically justified**
- **Environmentally beneficial in terms of congestion reduction**

In view of the demonstrated cost advantage and technical robustness of UHPFRC-based elevated corridors, it is recommended that the proposed Bengaluru corridors of Swami Vivekananda Metro Station to Silk Board Junction on Hosur Road be taken forward under the EPC mode of tendering. This approach will ensure timely execution, cost rationalization, and accountability, while aligning with national best practices and delivering significant savings compared to conventional elevated structures.

With an Economic Internal Rate of Return (EIRR) of 16.80%, which exceeds the benchmark hurdle rate of 12.00%, along with associated social and developmental benefits, the project is economically viable and recommended for implementation**.**

This project is proposed to execute under EPC (Engineering, Procurement and Construction) mode, wherein the contractor is paid by the client in stages as per the agreed payment schedule during construction and upon completion. Implementation under annuity or toll-based systems is challenging in dense urban areas, as toll collection is both impractical and socially sensitive. Instead, cost recovery for such infrastructure is more effectively achieved through appropriate urban taxation mechanisms across the city, enabling pooled funding for projects of this nature.

For effective implementation, a Special Purpose Vehicle (SPV) under BSMILE has been established. The Board of Directors should be vested with full powers, and the Managing Director delegated adequate authority to ensure timely execution without bureaucratic delays.